HEWLETT hp PACKARD

OPERATING AND SERVICE MANUAL

12588A

POWER FAILURE INTERRUPT WITH AUTOMATIC RESTART COMPUTER ACCESSORY KIT

(FOR THE 2116B COMPUTER)

Card Assembly
12588-6001, Rev. 929

Note

This manual should be retained with Volume Two of the HP 2116B Computer documentation.

12588-9002

HEWLETT-PACKARD COMPANY
11000 WOLFE ROAD, CUPERTINO, CALIFORNIA, U.S.A.

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12588A

POWER FAILURE INTERRUPT WITH AUTOMATIC RESTART COMPUTER ACCESSORY KIT

(FOR THE 2116B/C COMPUTER)

UPDATING SUPPLEMENT FOR OPERATING AND SERVICE MANUAL

16 AUG 1971

MANUAL IDENTIFICATION

Manual Serial No. Prefix: NA

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SUPPLEMENT DESCRIPTION

The purpose of this supplement is to adapt the manual to instruments containing production improvements made subsequent to the printing of the manual and to correct manual errors. Enter the new information (or the Change Number, if more convenient) into the appropriate places in the manual, identified at left.

INSTRUMENT CHANGES

Serial No. Prefix	Change

ASSEMBLY CHANGES

Ref Des	Description	HP Part No.	Rev	Changes

Changes 1 through 3 dated 25 November 1970.

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11000 Wolfe Road, Cupertino, California 95014, Tel. (408) 257-7000, TWX 910-338-0221

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CHANGE	DESCRIPTION
1	Unless specified otherwise in the changes listed below, change all references in the manual that read "2116B" Computer to read "2116B/C" Computer.
2	Page 2-1, paragraph 2-15. Change the second line of step "b" to read ". . . from slot 1 of the card cage in the HP 2116B or from slot 6 of the card cage in the HP 2116C Computer." Change the third line of step "c" to read ". . . and install it in slot 1 of the HP 2116B or slot 6 of the HP 2116C Computer."
3	Page 5-1, paragraph 5-12. Change the second line of step "b" to read ". . . from slot 3 of the HP 2116B or slot 15 of the HP 2116C if the computer has this optional card installed." In the note that follows step "e," change the ninth line to read ". . . 02116-9153 for the HP 2116B Computer or 02116-91756 for the HP 2116C Computer."
4	Page 3-1, paragraph 3-10. Change the eighth line to read ". . . rupt, location 000004 should contain a HLT 04,C . . .".
5	Page 3-1, table 3-1. In the MNEMONIC AND SELECT CODE column, change "HLT C 04" to read "HLT 04,C".
6	Page 2-1/2-2, paragraph 2-10. Change the position markings that read "2116B" to read "2116B/C".
7	Page 5-4, table 5-1. Interchange the HP Part No., Description, Mfr Code, and Mfr Part No. for resistors R63 and R64.
8	Page 5-5/5-6, figure 5-3. Add signal mnemonic $\overline{IR15}$ at pin 4 of the logic diagram. (This signal is used by the HP 2116C Computer at pin 4 and by the HP 2116B Computer at pin 9.) Make the corrections illustrated in figure US-1 to the parts location diagram.

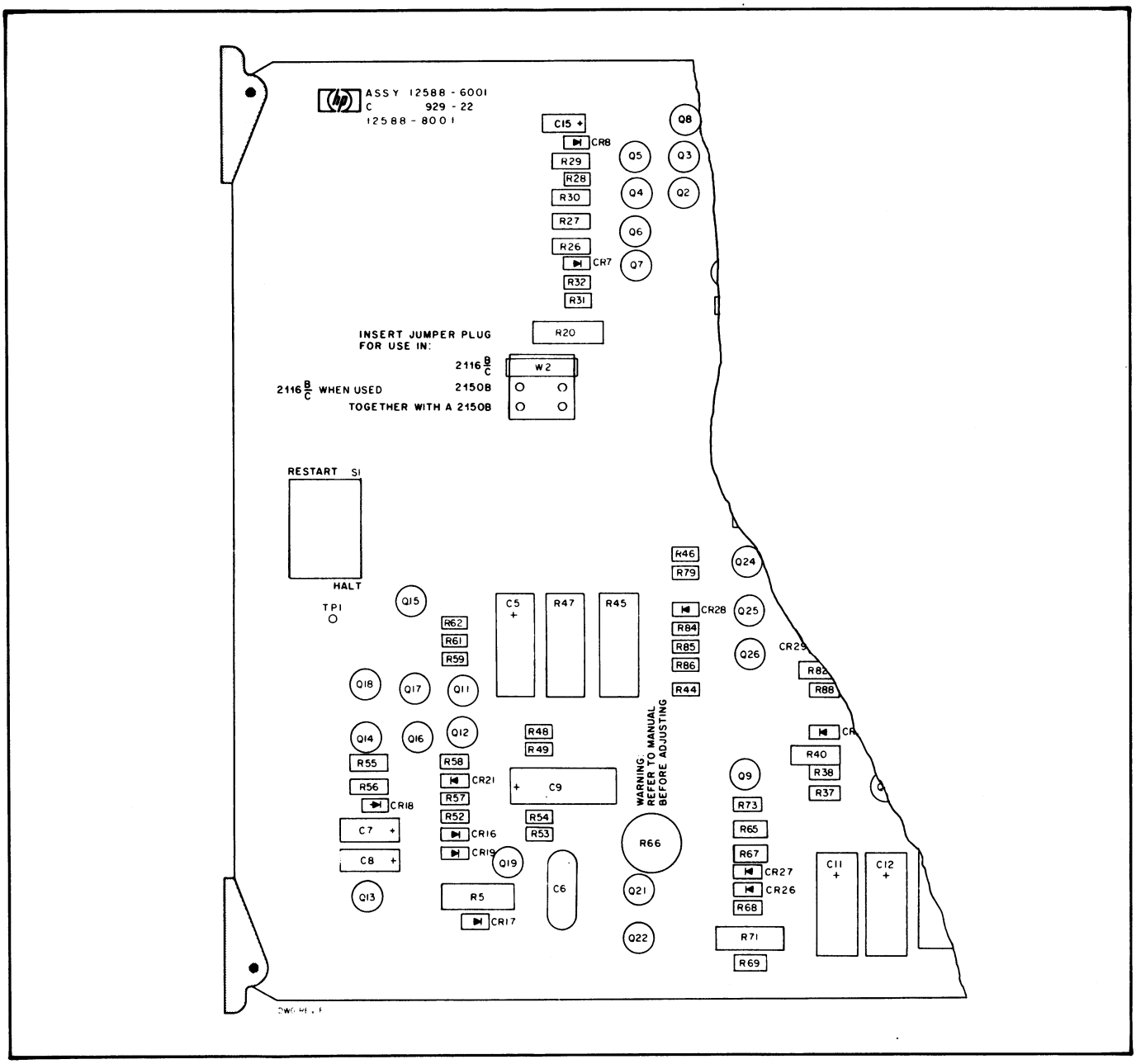

Figure US-1. Parts Location Corrections to Figure 5-3.

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SECTION I
GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. This operating and service manual covers general information, installation, operation and programming, theory of operation, maintenance instructions, and replaceable parts information for the Hewlett-Packard 12588A Power Failure Interrupt With Automatic Restart option for the HP 2116B Computer. When included in the purchase order for the computer, the option is installed and tested in the computer at the factory. For field installation, the option is obtained by ordering the HP 12588A Accessory Kit.

1-3. ACCESSORY KIT CONTENTS.

1-4. The 12588A Accessory Kit contains the power-failure auto-restart card (part no. 12588-6001) and the operating and service manual (part no. 12588-9002).

1-5. GENERAL DESCRIPTION.

1-6. When primary power to the computer fails, or drops below a safe operating level, the power-failure auto-restart card signals an interrupt request. This starts a programmed shutdown routine that saves the contents of the computer registers and memory. A two-position switch mounted on the card determines the restart mode of operation when power is restored. If the switch is in the RESTART position, the programmed restart routine restores the registers and the computer program will start running automatically from the point of interruption. If the switch is in the HALT position, the computer will go into the halt mode.

1-7. The optional power-failure auto-restart card replaces the standard power failure interrupt card (part no. 02116-6175) supplied with the basic HP 2116B Computer. The optional card is directly compatible with the basic HP 2116B Computer, and with HP 2116B Computers used in systems that include the HP 2150B Input/Output and Memory Extender, HP 2151A Input/Output Extender, or HP 2160A Power Supply Extender.

1-8. IDENTIFICATION.

1-9. This operating and service manual is identified on the title page by accessory kit designation and nomenclature, card assembly part number and revision code, manual part number, and publication date. Refer to the information presented in the following paragraphs and ensure that this manual applies to the equipment being serviced.

1-10. Standard accessory kit designations consist of five digits and a letter (00000A). If the designation of your kit does not agree with that on the title page of this manual, there are differences between your kit and the kit described in this manual. These differences are described in manual supplements available at the nearest HP Sales and Service Office listed at the back of this manual.

1-11. Printed-circuit boards used for plug-in card assemblies or fixed wired assemblies are identified by a letter, a revision code, and a division code etched or stamped on the board (e.g. A-921-22). The letter code identifies the version of the etched trace pattern on the unloaded board. The revision code (three middle digits) refers to the electrical characteristics of the loaded board. The division code (last two digits) identifies the Hewlett-Packard division which manufactured the board. If the revision code stamped on the printed-circuit board does not agree with the revision code on the title page of this manual, there are differences between your board and the board described in this manual. These differences are described in manual supplements available at the nearest HP Sales and Service Office.

1-12. CURRENT REQUIRED.

1-13. The following specifies the current required by the power-failure auto-restart card from the computer power supply (in excess of that required by the standard power failure interrupt card):

+12V	-12V	-2V	+4.5V
60 mA	40 mA	0	0

SECTION II
INSTALLATION

2-1. INTRODUCTION.

2-2. This section contains information on unpacking, inspection, and installation of the optional power-failure auto-restart card.

2-3. UNPACKING AND INSPECTION.

2-4. If the shipping carton is damaged upon receipt, request that the carrier's agent be present when the equipment is unpacked. Inspect the card for damage (scratches, cracks, loose components, etc.). If the card is damaged and fails to meet specifications, notify the carrier and the nearest HP Sales and Service Office immediately. (HP Sales and Service Offices are listed at the back of this manual.) Retain the shipping container and the packing material for the carrier's inspection. The HP Sales and Service Office will arrange for the repair or replacement of the damaged equipment without waiting for any claims against the carrier to be settled.

2-5. WARNING NOTICE.

2-6. The warning notice printed on the card, "WARNING: READ THE MANUAL BEFORE ADJUSTING", refers to the adjustment of variable resistor R66. The variable resistor is set at the factory to start an interrupt as soon as the primary power to the computer falls below the threshold level of 100 volts ac, rms. Adjustment of the variable resistor is not required unless it is desired to reset the level of the threshold voltage (refer to paragraph 5-7). Test point TP1 on the card is used only in adjusting the threshold voltage.

2-7. RESTART/HALT SWITCH.

2-8. The RESTART/HALT switch on the front edge of the card controls the mode of operation. When the switch is set to the RESTART position, both the shutdown and the restart routines will initialize automatically. When the switch is set to the HALT position, the shutdown routine will initialize automatically as soon as power falls to the threshold voltage, but the computer will go into a halt mode as soon as power is restored. The halt mode of operation is similar to the operation of the power failure interrupt card (part no. 02116-6175) which is standard in the HP 2116B Computer.

2-9. PLUG-IN JUMPER (W2).

2-10. The plug-in jumper mounted on the card is inserted into either the position marked "2116B" or "2116B WHEN USED TOGETHER WITH A 2150B", as appropriate. The position marking "2150B" is not applicable to this card.

2-11. FACTORY INSTALLATION.

2-12. If purchased as part of an initial computer order, the option is installed at the factory and is ready for operation upon receipt of the computer. When the computer is originally installed, conduct the diagnostic program procedure (part no. 02116-91769) contained in the Manual of Diagnostics. If test results are satisfactory, the option is ready for normal use.

2-13. FIELD INSTALLATION.

2-14. Field installation of the option consists of replacing the standard power failure interrupt card with the optional power-failure auto-restart card. The RESTART/HALT switch on the optional card is set to the desired position and the option is tested by use of the diagnostic program procedure provided in the accessory kit.

2-15. To field install the optional card, proceed as follows:

a. At the front panel of the computer, press and release the POWER switch to turn off power.

b. Open the computer door and remove the power failure interrupt card (part no. 02116-6175) from slot 1 of the card cage.

c. Hold the optional power-failure auto-restart card (part no. 12588-6001) with component side to the right and install it in slot 1.

d. Perform the diagnostic program procedure (part no. 02116-91769) contained in the Manual of Diagnostics. If test results are satisfactory, the option is ready for normal use.

SECTION III
OPERATION AND PROGRAMMING

3-1. INTRODUCTION.

3-2. This section contains operating and programming information for the power failure interrupt with automatic restart option. Control of the option at the front panel of the computer is described and a sample subroutine (table 3-2) for the option is included.

3-3. FRONT PANEL CONTROL.

3-4. PRESET AND HALT SWITCHES.

3-5. In addition to controlling the basic computer, the PRESET and HALT switches also control the power-failure auto-restart card. The PRESET switch is lighted when the Flag FF on the card is set. Pressing the PRESET switch will reset the Flag FF and turn off the automatic restart circuits on the card. Pressing the HALT switch will also turn off the automatic restart circuits.

3-6. POWER SWITCH.

3-7. When the option is in the automatic restart mode (RESTART/HALT switch set to RESTART), the computer will restart automatically every time the POWER switch is turned on. This can be prevented by a subroutine in memory, or by pressing and holding either the HALT or the PRESET switch while the POWER switch is pressed and released to turn on power.

3-8. PROGRAMMED CONTROL.

3-9. HALT MODE INSTRUCTION.

3-10. When the computer is equipped with either the standard power failure interrupt card (part no. 02116-6175), or the optional power-failure auto-restart card (part no. 12588-6001) with the RESTART/HALT switch set to the HALT position, a power failure will cause the card to interrupt to location 000004. If the computer memory does not contain a subroutine to service the interrupt, location 000004 should contain a HLT, C 04 (103004) instruction. Then, when power fails, the computer will halt and the automatic restart circuits will be turned off. When power is restored the PRESET switch will light to indicate that a power failure has occurred.

3-11. SHUT-DOWN AND START-UP CYCLE TIME.

3-12. In the event a power failure occurs immediately after a start-up routine has begun, there must be enough time remaining at the end of the start-up routine to complete the shut-down routine. The total number of memory cycles in the two routines, start-up and shut-down, should be less than 200. For example, the total should be less than the number of memory cycles in a routine of 50 memory reference instructions (2 cycles each) and 100 register reference instructions (1 cycle each).

3-13. INTERRUPT SYSTEM OPERATION.

3-14. The power-failure auto-restart card is program-controlled through the interrupt system. It is given the highest priority in the system, select code 04, so that the shut-down program will have enough time to save the contents of the computer registers when power fails. Unlike input/output (I/O) interface cards used with the system, the power-failure auto-restart card has no Control FF. This prevents inadvertently turning it off with a CLF 00 instruction (refer to table 3-1).

Table 3-1. Machine Language Instructions for the Power-Failure Auto-Restart Card

MNEMONIC AND SELECT CODE	MACHINE LANGUAGE (OCTAL)	AFFECT ON POWER-FAILURE AUTO-RESTART CARD
CLC 04	106704	Turns on the restart logic so that the computer will restart when power is restored after a momentary power failure.
CLF 00	103100	Disables the entire interrupt system, except for power failure interrupt, select code 04.
CLF 04	103104	Turns off the restart logic, but does not reset Flag FF.
HLT,C 04	103004	Turns off the restart logic and halts the computer, but does not reset the Flag FF.
SFC 04	102204	Skips to the next instruction if the interrupt was caused by power failure. Does not skip if interrupt occurred while power was going back up.
SFS 04	102304	No affect.
STC 04	102704	Resets the Flag FF so that if power fails again, the Flag FF can be set to initiate another power failure interrupt. It also turns off the restart logic.
STF 04	102104	No affect.

Table 3-2. Sample Program for Power-Failure Auto-Restart Option

```
0001                ASMB,A,B,L,T
0002*   SET-UP POWER-FAIL TRAP CELL CONTENTS POINTING
0003*     TO POWER-FAILURE/AUTO-RESTART SUBROUTINE
0004*
0005  00004                 ORG 4B
0006  00004 014100          JSB SUBR
0007*
0008*       POWER-FAIL/AUTO-RESTART SUBROUTINE
0009*
0010  00100                 ORG 100B
0011  00100 000000  SUBR    NOP
0012  00101 102204          SFC 4B      SKIP IF INTERRUPT WAS CAUSED BY A
0013*                                       POWER FAILURE
0014  00102 024117          JMP UP      POWER IS BEING RESTORED, RESET
0015*                                       STATE OF COMPUTER SYSTEM
0016*
0017*       POWER GOING DOWN. SAVE STATE OF COMPUTER SYSTEM
0018*
0019  00103 070137  DOWN    STA ASTR    SAVE CONTENTS OF A-REGISTER
0020  00104 003400          CCA         SET SWITCH INDICATING COMPUTER WAS
0021  00105 070142          STA RSTR      RUNNING WHEN POWER FAILED
0022  00106 074140          STB BSTR    SAVE CONTENTS OF B-REGISTER
0023  00107 001520          ERA,ALS     TRANSFER CONTENTS OF E-REGISTER TO
0024*                                       A-REGISTER, BIT 15
0025  00110 102201          SOC         INCREMENT A-REGISTER CONTENTS IF
0026  00111 002004          INA           O-REGISTER IS SET
0027  00112 070136          STA EOSTR   SAVE E-AND O-REGISTER CONTENTS
0028  00113 060100          LDA SUBR    SAVE CONTENTS OF P-REGISTER
0029  00114 070141          STA PSTR      AT TIME OF POWER FAILURE
0030*                        .   .      INSERT USER-WRITTEN
0031*                        .   .        ROUTINE TO SAVE
0032*                        .   .        I/O DEVICE STATE
0033  00115 106704          CLC 4B      TURN ON RESTART LOGIC SO COMPUTER
0034*                                       WILL RESTART WHEN POWER
0035*                                       IS RESTORED AFTER MOMENTARY
0036*                                       POWER FAILURE
0037  00116 102000          HLT
0038*
0039*       POWER IS COMING UP; RESTORE STATE OF
0040*         COMPUTER SYSTEM
0041*
0042  00117 060142  UP      LDA RSTR    WAS COMPUTER RUNNING WHEN POWER
0043  00120 002003          SZA,RSS       FAILED?
0044  00121 024134          JMP HALT        NO
0045  00122 002400          CLA             YES; RESET COMPUTER RUN
0046  00123 070142          STA RSTR          SWITCH TO INITIAL STATE
0047*                        .   .      INSERT USER-WRITTEN
0048*                        .   .        ROUTINE TO RESTORE
0049*                        .   .        I/O DEVICE STATE
0050  00124 060136          LDA EOSTR   RESTORE THE
0051  00125 103101          CLO           E-AND
0052  00126 000036          SLA,ELA       O-REGISTER
0053  00127 102101          STF 1         CONTENTS
0054  00130 060137          LDA ASTR    RESTORE CONTENTS OF A-REGISTER
0055  00131 064140          LDB BSTR    RESTORE CONTENTS OF B-REGISTER
0056  00132 102704          STC 4B      RESET FLAG FF SO WHEN POWER FAILS
0057*                                       AGAIN, ANOTHER INTERRUPT
0058*                                       REQUEST WILL BE SIGNALED
0059*                                       BY POWER-FAIL INTERRUPT
0060*                                       LOGIC
0061  00133 124141          JMP PSTR,I  TRANSFER CONTROL TO PROGRAM IN
0062*                                       EXECUTION AT TIME OF POWER-FAIL
0063  00134 103104  HALT    CLF 4B      TURN OFF RESTART LOGIC
0064  00135 102000          HLT
0065*
0066*
0067  00136 000000  EOSTR   OCT 0
0068  00137 000000  ASTR    OCT 0
0069  00140 000000  BSTR    OCT 0
0070  00141 000000  PSTR    OCT 0
0071  00142 000000  RSTR    OCT 0
0072                        END
**  NO ERRORS*
```

3-15. When the Flag FF on the power-failure auto-restart card is set, all I/O devices are prevented from interrupting, and direct memory access (DMA) is prevented from making transfers.

3-16. MACHINE LANGUAGE INSTRUCTIONS.

3-17. The reaction of the power-failure auto-restart card to certain I/O instructions differs from that of most I/O channels. Refer to table 3-1 for a description of how these instructions affect the card.

3-18. SAMPLE SUBROUTINE.

3-19. Table 3-2 is a minimal subroutine for the power-failure auto-restart card. If the computer is running a program when power fails, this subroutine will save the contents of A-, B-, and P-registers, return the contents to these registers after power is restored, and automatically restart the main program. If the computer is not running a program when power fails, this subroutine will put the computer in the halt mode after power is restored.

SECTION IV
THEORY OF OPERATION

4-1. INTRODUCTION.

4-2. This section contains an overall functional description and a detailed circuit description of the power-failure auto-restart card.

4-3. OVERALL FUNCTIONAL DESCRIPTION.

4-4. A simplified block diagram of the card is shown in figure 4-1. The four main functions of the card are:

a. Detecting power failures.
b. Initiating an interrupt when power fails.
c. Restarting the main program when power is restored.
d. Halting the computer.

4-5. The power failure detection circuits consist of the power-on monitor, restart delay, thermal detector and threshold detector. The power-on monitor circuit senses all seven regulated supplies in the computer and also the supplies in the power supply extender. When power is normal the Power On Normal (PON), Power Indicator Lamp (PIND), and "not" Power On/Off Pulse ("not" POFP) signals are generated. The PON and PIND signals are sent to the front panel coupler card in the computer. The PIND signal lights the POWER lamp. Whenever a regulated supply falls below normal, the "not" PON, "not" PIND, and POFP signals are generated. The POFP signal enables the Fetch Phase FF on the timing generator card. The false PON signal initiates the restart interrupt, latches the Power Supply On (PSO) signal, and disables the restart control circuit.

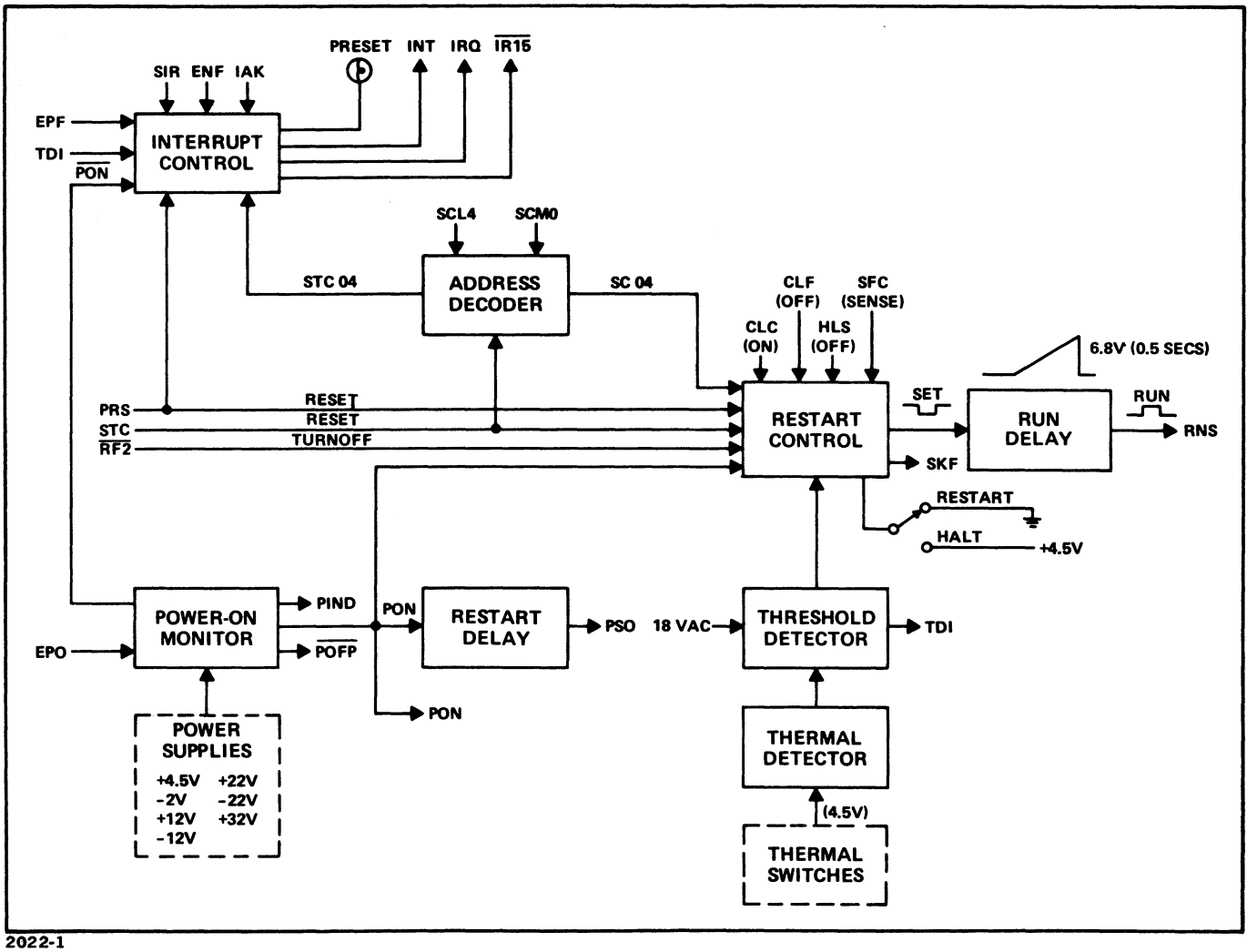

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Figure 4-1. Power-Failure Auto-Restart Card Functional Block Diagram

4-6. The restart delay circuit ensures that the regulated power supplies reach normal operating level when the computer is starting automatically after a power failure. The PSO signal is gated on and off at 8-second intervals until the PON signal occurs, then the PSO signal holds true.

4-7. The threshold detector monitors the power line through the 18-volt ac unregulated bus. If the line input drops below 100 volts, the threshold detector generates an interrupt and disables the restart control circuit. The threshold detector is also enabled by the thermal detector when a thermal switch opens or when power goes off. When RESTART/HALT switch S1 is in the RESTART position and power is restored, the restart control circuit is enabled. In the HALT position, the restart control circuit is inhibited.

4-8. The interrupt control logic is similar to all computer I/O interrupt circuits, except that it cannot be turned off by a Clear Flag (CLF) instruction or any other instruction. The interrupt control logic is initialized with a Set Control (STC 04) instruction or by the front panel PRESET switch (PRS). An interrupt can be initiated by a "not" PON signal, an External Power Fail (EPF) signal, or a threshold detector interrupt (TDI) signal. When an interrupt occurs the PRESET lamp lights and the required interrupt (INT) and Interrupt Request (IRQ) signals are sent to the computer.

4-9. The address decoder logic decodes Select Code 04 which is used to address the option.

4-10. The automatic restart logic consists of the restart control and the run (ramp) delay. The restart control can be set with a Clear Control (CLC 04) instruction, and reset with a CLF 04 instruction, a Halt Switch (HLS) signal, a PRS signal, or a STC 04 instruction. The restart control is enabled by the PON signal and the restart (switch) signal when power is restored. The negative output of the restart control starts the ramp delay. The ramp reaches 6.8 volts after approximately 0.5 seconds and a true RNS signal is sent to the timing generator to enable the run mode. Since the "not" RF2 signal is true before RNS occurs, the "not" IR15 signal is true and is sent to the timing generator card to override the indirect phase that normally inhibits interrupt. A true RNS signal makes "not" RF2 go false and the restart control circuit is turned off. Since the first instruction of a power fail subroutine is Skip If Flag Clear (SFC 04), a Skip On Flag (SKF) signal is generated if power is failing (Restart Control FF is clear).

4-11. DETAILED DESCRIPTION.

4-12. The following paragraphs provide a detailed theory of operation for the card, based upon the logic diagram shown in figure 5-4.

4-13. POWER FAILURE DETECTION.

4-14. THRESHOLD DETECTOR. The threshold detector (transistors Q21 and Q22) senses a line voltage drop below a threshold level by monitoring the 18-volt secondary of power transformer T1 in the computer power supply. The 18 volts from the secondary feeds to pins 79 and 80 of the card through diodes CR23 and CR24, across a voltage divider to the base of transistor Q21. When primary power is above the threshold level, normally 100 volts ac rms, Q21 is on and Q22 is off. When primary power drops below the threshold level, Q21 is off and Q22 is on, a positive pulse of approximately 1.5 volts above card ground is fed to the squaring network.

4-15. THERMAL DETECTOR. The thermal detector (transistors Q11 and Q12) senses a power failure or a power interruption by monitoring the primary power relay K1 in the computer power supply. Turning on the POWER switch connects an unregulated +4.5 volts from the secondary of power transformer T1 through the contacts of K1, through thermal switches S301 and S302 in the power supply and S1 in the memory module decoder card, through terminal 52 of the option and into transistor Q11. The +4.5 volts holds transistor Q11 off and Q12 on. When a thermal switch opens or the POWER switch is turned off, the +4.5 volts is removed from the base of Q11 and from capacitor C5. The capacitor voltage decays until Q11 is turned on, which feeds a positive pulse through diode CR22 to the squaring network.

4-16. SQUARING NETWORK. The outputs of both the threshold detector and the thermal detector are "or-tied" and fed into a squaring network consisting of gates MC67A, MC67B, and MC16A. The output of the network is the power failure signal that feeds interrupt logic gate MC46B and restart control gate MC56A, through switch-enabled gate MC57B.

4-17. POWER-FAIL INTERRUPT CIRCUITS.

4-18. THE FIRST TIME PERIOD FIVE (T5). The power failure signal from gate MC16A or the extender power fail (EPF) signal from pin 42 feeds one input of "nand" gate MC46B. The true reset output of the Flag flip-flop (FF) is on the second input of the gate and a false Service Interrupt Request (SIR) signal is on the third input. At the first T5 after power fails, the SIR signal goes true, enabling the power failure signal to gate through and set the Flag Buffer FF. The true set output of the Flag Buffer FF feeds one input of "nand" gate MC66D. A false Enable Flag (ENF) signal is on the second input of the gate.

4-19. THE NEXT TIME PERIOD TWO (T2). At the next T2 after the first T5 the ENF signal goes true, enabling the Flag Buffer FF set output to gate through and set the Flag FF. The false reset output of the Flag FF now inhibits gate MC46B from setting the Flag Buffer FF. The true set output of the Flag FF feeds gate MC77B, inverts and drives the Priority Low (PRL) line false. The true set output of the Flag FF also feeds one input of gate MC46C. The true set output of the Flag Buffer FF is on the second input of the gate and a false SIR signal is on the third.

4-20. THE SECOND TIME PERIOD FIVE (T5). At T5 in the second machine cycle after power failure, the SIR signal goes true, enabling the Flag FF to set the Interrupt Request FF. The true set output of the Interrupt Request FF, through the gates MC17B, and MC37B, drives the Interrupt Request (IRQ), and Interrupt (INT) signal lines true.

4-21. The IRQ signal feeds the encoding matrix of the I/O address card in the computer to form part of service request address 04.

4-22. The INT signal feeds directly to the phase logic on the timing generator card, to set the PH4 FF.

4-23. Since the INT signal feeds directly to the phase logic (bypassing the Interrupt System Enable FF on the I/O control card), the instruction that normally disables the entire interrupt system, CLF 00, will not disable the option.

4-24. RESETTING FLAG BUFFER FF. After the computer has entered an interrupt sequence, an Interrupt Acknowledge (IAK) signal is returned from the I/O control card. The IAK signal feeds from pin 10 to "nand" gate MC26A. The second input to the gate, the true set output of the Interrupt Request FF, enables the IAK signal to gate through and reset the Flag Buffer FF.

4-25. RESTART INTERRUPT.

4-26. When the computer is initially turned on, and when it is restarted after a power failure, the Power On Normal (PON) signal from the power-on monitor (transistors Q2 through Q8) is momentarily false at the output gate MC87A. The false PON signal sets the Flag Buffer FF and the Flag FF. The true set output of the Flag Buffer FF feeds one input of gate MC46C. The true set output of the Flag FF is on a second input, and a false SIR signal is on a third.

4-27. THE FIRST TIME PERIOD FIVE (T5). At the first T5 after the computer is restarted by restart control after a power failure, the SIR signal goes true. This enables the true set output of the Flag FF to gate through, invert, and set the Interrupt Request FF, to make the next phase an interrupt phase.

4-28. PRS SIGNAL. Pressing the PRESET switch feeds the Preset Switch (PRS) signal to pin 78. The PRS signal, inverted by gate MC36B, resets the Flag Buffer FF, the Flag FF, and the Restart Control FF.

4-29. PRESET LAMP. If the RESTART/HALT switch S1 is set to the HALT position, and power fails, the PRESET lamp will turn on and stay on when power is restored. When the computer is initially turned on or restarted, the Flag FF is set by the momentarily false PON signal. The true set output of the Flag FF makes the base of transistor Q1 positive. This turns on Q1 and completes a +7 volt circuit through the PRESET lamp to ground.

4-30. STC SIGNAL. The Set Control (STC) signal feeds through pin 22 to gate MC36A. When a signal from the address decoder enables gate MC36A, the STC signal resets the Flag Buffer FF, the Flag FF, and the Restart Control FF. This prepares the card to produce another interrupt request when power fails again.

4-31. RESTART CIRCUITS.

4-32. POWER-ON MONITOR. The power-on monitor (transistors Q2 through Q8) senses all regulated supplies in the main power supply of the computer and the power supplies in the extender modules (HP 2150B, 2151A, 2160A). The collectors of the transistors in the power-on monitor are tied to a common output bus. When the regulated supplies are all up to normal operating level, the signal on the bus is true, providing the Power On Normal (PON) signal. The PON signal feeds through gate MC27A to gate MC87A. If the regulated supplies in an extender are all up to normal operating level, a true Extender Power On (EPO) signal is present at pin 37. This signal is routed through jumper W4 to enable gate MC87A and put a true signal level on the PON line feeding gate MC76A and MC77A. If no extender is used, gate MC87A is enabled by the +12 volt line routed through jumper W2. The PON signal through gate MC76A feeds the front panel coupler card; through the power lamp driver it becomes the Power Indicator Lamp (PIND) signal; and through gate MC77A it becomes the "not" Power On/Off Pulse (POFP) signal. The PON signal from gate MC87A also feeds the Flag Buffer FF, the Flag FF, the Restart Control FF, the restart control gate, and the restart delay logic.

4-33. RESTART DELAY. When the computer is restarting automatically after a power failure, the restart delay logic ensures that all supplies will reach their normal operating level. It does this by providing a 2-second Power Supply On (PSO) signal to the logic supply regulator card in the computer power supply. The PSO signal is controlled by the thermal detector, the power-on monitor, and an astable multivibrator (Q13 and Q14) in the restart delay logic.

4-34. Transistor Q12 in the thermal detector is normally on, making the emitters of transistors Q16 and Q17 positive. The multivibrator output turns on Q15, which turns on Q16, making the PSO signal true. A true PON signal from the power-on monitor turns on Q18, which turns on Q17 which latches the PSO signal true.

4-35. The multivibrator provides a 10-second square wave that is negative for 2 seconds and positive for 8 seconds. Transistor Q15 is connected to the negative side of the multivibrator, transistor Q14. The multivibrator is synchronized through diode CR19 and transistor Q19, forcing the negative side output to come on first. This prevents a starting delay of 8 to 10 seconds when the power switch is used to turn on the computer.

4-36. RESTART CONTROL. After a power failure, a false PON signal has set the Restart Control FF. The true set output of the FF feeds one input of the restart control

gate MC56A. The false PON signal feeds a second input of the gate. A false power failure signal from the squaring network, inverted to true by gate MC57B, feeds a third input. A true "not" Run FF2 ("not" RF2) signal from the timing generator card, feeds the fourth. At this time all gate inputs except PON are true. As soon as the increasing power supply voltages reach normal, the PON signal goes true. This makes all four inputs of the restart control gate true and its output false.

4-37. The false output from the restart control gate (through the delay logic and Schmitt trigger) makes the Run Switch (RNS) signal true, which has the same effect as pressing the RUN switch. The RNS signal sets Run FF 1 on the timing generator card. Through one circuit path the false restart control gate output causes gate MC76B to provide the RNS signal (see paragraph 4-38). Through a second circuit path, a true restart control gate output causes the same gate to inhibit RNS (see paragraph 4-42).

4-38. RNS SIGNAL GENERATION. The false restart control gate output, inverted by gate MC36C, makes one input of gate MC76B true. It also starts a voltage ramp in the delay logic. By turning off transistor Q23, the false restart control gate output makes the collector of Q23 go positive. This starts capacitor C17 charging through resistors R77 and R78. The base of transistor Q24 is connected to the positive side of the capacitor, and the emitter to -2 volts through 6.8-volt Zener diode CR28. Capacitor C17 charges for approximately 500 milliseconds to reach +6.8 volts. At this point the Zener diode breaks down and turns on transistor Q25 in the Schmitt trigger circuit. Through diode CR29, the positive output of the Schmitt trigger enables gate MC76B. The false restart control gate output, inverted by gate MC36C, is gated through MC76B onto the RNS signal line at pin 60 to set Run FF1 on the timing generator card.

4-39. SETTING INTERRUPT. The momentarily false PON signal that occurs at initial start and restart, sets the Flag Buffer FF and the Flag FF. These FFs are ready to interrupt as soon as the computer starts to run. When the SIR signal comes up, the Flag FF output feeds through gate MC46C and sets the Interrupt Request FF. The true set output of the Interrupt Request FF, through gates MC16B, MC17B, and MC37B drives the Interrupt Request (IRQ), Interrupt (INT), and "not" Instruction Register bit 15 ("not" IR15) signal lines true.

4-40. The IRQ signal feeds the encoding matrix on the I/O address card to form part of service request address 04.

4-41. INDIRECT OVERRIDE. The INT and "not" IR15 signals go directly to the phase logic on the timing generator card to be "anded" with the RF1 signal from Run FF1 to set the PH4 FF. Routing the INT and "not" IR15 signals directly to the phase logic has the effect of overriding the Indirect instructions. The instructions Jump Indirect (JMP,I) and Jump to Subroutine Indirect (JSB,I), which normally inhibit all interrupts, will not inhibit the restart interrupt. Note that this effect occurs during restart but not during power failure described in paragraph 4-17. The reason for this difference is that when power is returning, the "not" RF2 signal from the timing generator card is true and drives "not" IR15 true. The "not" IR15 signal enables gate MC22C in the phase logic on the timing generator card to feed the INT signal to the set input of the PH4 FF. Thus the JSB Indirect or JMP Indirect signals from the I-register cannot inhibit the INT signal from starting an interrupt phase.

4-42. RNS SIGNAL INHIBIT. If the subroutine contains a halt instruction, the computer will still keep trying to start as long as the RNS signal is true. For this reason it is desirable to inhibit the RNS signal quickly. This is done by the "not" RF2 signal going false. When the "not" RF2 signal goes false, the output of the restart control gate goes true, is inverted to false by gate MC36C, and inhibits the RNS output of gate MC76B.

4-43. RESTART/HALT. The Restart/Halt circuit comprises the RESTART/HALT switch (S1) and gate MC57B. When the switch is in the RESTART position, gate MC57B is enabled. A false power failure signal gates through, inverts, and enables the restart control gate. When primary power is restored, the computer will restart automatically, immediately interrupt to location 000004, and execute whatever instruction is there. When the switch is in the HALT position, the +4.5 volts inhibit gate MC57B, which inhibits the restart control gate. When primary power is restored, the computer will immediately halt, and the PRESET indicator will light.

4-44. ADDRESS AND CONTROL CIRCUITS.

4-45. ADDRESS DECODER. Address decoder gate MC27C receives the Input/Output Instruction Group, I/O Buffered (IOGE,B) signal, the Select Code Least Significant Digit Octal 4 (SCL4) signal, and the Select Code Most Significant Digit Octal 0 (SCM0) signal. The IOGE(B) signal is decoded from the five bits (15, 14, 13, 12, and 10) of a standard input/output instruction. Bits 5, 4, 3, 2, 1, and 0 are decoded to generate the SCM0 and SCL4 signals that identify the select code for the power-failure auto-restart card. The address decoder enables instructions intended for this address (select code 04) to be gated to the interrupt circuits and the restart circuits.

4-46. SKIP ON POWER FAILURE LOGIC. The skip on power failure logic, gates MC17A and MC27B, tests the status of the Restart Control FF. The instruction Skip If Flag Clear (SFC 04) enables the address decoder and sends an SFC signal to gate MC27B. If power is failing, the Restart Control FF will normally be reset, enabling gate MC27B. The SFC signal will then feed through to one input of gate MC17A, which is enabled by a true address decoder output. The output of gate MC17A is the Skip On Flag (SKF) signal. If power is failing the SKF signal is true, and a skip is executed. If the computer is in the process of restarting, the SKF signal is false and a skip is not executed. This logic does not contain Skip if Flag Set (SFS) circuitry.

4-47. INPUT/OUTPUT INSTRUCTION GROUP (IOG) CONTROL LOGIC. The IOG control logic is not connected to the power-failure auto-restart circuits. The IOG control logic is mounted on the card and connected to the IOG line in the same manner as the standard power failure interrupt card. The circuit is used only in computers that have the memory protect option, and is controlled by the memory parity check (parity error) signal (MPC).

SECTION V
MAINTENANCE

5-1. INTRODUCTION.

5-2. This section contains preventive maintenance information, testing and troubleshooting, a threshold voltage adjustment procedure, a reference designation index, and maintenance diagrams for the power-failure auto-restart card.

5-3. PREVENTIVE MAINTENANCE.

5-4. Perform the following preventive maintenance procedure every three months:

a. Visually inspect components on the power-failure auto-restart card for damage caused by excessive heat.

b. Perform the diagnostic program procedures (part no. 02116-91769) for the card as outlined in the Manual of Diagnostics.

5-5. TESTING AND TROUBLESHOOTING.

5-6. Testing and troubleshooting for the power-failure auto-restart card is accomplished by performing the diagnostic program procedures in the Manual of Diagnostics and analyzing the probable cause of error halts if the card malfunctions. To further isolate trouble, refer to the maintenance diagrams in figures 5-2 and 5-3.

5-7. THRESHOLD VOLTAGE ADJUSTMENT.

5-8. This procedure describes adjustment of the threshold detector to determine the power line voltage at which power failure interrupt occurs. The threshold voltage is factory-set at 100 volts ac for 115-volt operation and at 200 volts ac for 230-volt operation.

5-9. EQUIPMENT REQUIRED.

5-10. The threshold voltage adjustment requires the following test equipment (or equivalent):

a. Oscilloscope, HP 180A.

b. VTVM, HP 400H (1 percent accuracy).

c. HP Extender board (part no. 02116-6040).

d. Screwdriver, common (blade approximately 3/32 inch wide).

e. Variable autotransformer.

Note

The autotransformer must be capable of supplying sufficient power for the computer. The HP 2116B requires 1000 to 1600 watts depending upon the optional equipment used. If necessary, all printed circuit cards for optional equipment may be removed to reduce power requirements before making the adjustment. Be sure to turn off power before removing or installing cards, and replace the cards with component side to the right. The autotransformer must be capable of reducing the power-line voltage to 100 volts rms if the computer is connected for 115-volt operation, or to 200 volts rms if the computer is connected for 230-volt operation.

5-11. ADJUSTMENT PROCEDURE.

5-12. Variable resistor R66 is set for a threshold of 100 volts ac rms. If an alternative threshold value is desired, use the following procedure, but substitute the alternative value for "100 volts ac rms". To set the threshold voltage, proceed as follows:

a. Press and release the POWER switch to turn off the computer.

b. Remove the parity error card (part no. 12591-6001) from slot 3 if the computer has this optional card installed.

c. Extend the power-failure auto-restart card from slot 1 by use of the extender board. Pull extra front panel cable from inside door to ease use of extender.

d. Connect the autotransformer between the computer and the power line.

e. Connect the VTVM to the output of the autotransformer.

Note

If the autotransformer does not have output terminals for connecting the VTVM, the connection can be made at the primary input of transformer T1 in the computer power supply, terminal board TB1. Refer to the computer power supply schematic diagram in Volume II, Installation and Maintenance Manual, part no. 02116-9153.

f. Adjust the autotransformer to furnish 115 volts rms to the computer (230 volts if the computer is connected for 230-volt operation.)

g. On the power-failure auto-restart card, set the RESTART/HALT switch to the RESTART position.

h. On the computer front panel, ensure that the LOADER switch is in the PROTECTED position.

i. Press and hold the PRESET switch while pressing and releasing the POWER switch to turn on the computer.

j. Adjust the oscilloscope for 1 volt/centimeter vertical deflection and 1 millisecond/centimeter sweep rate.

k. Connect the oscilloscope vertical input between test point TP1 and the negative lead of capacitor C11 (card ground) on the card.

l. To adjust the threshold voltage for 100 volts ac rms decrease the autotransformer output to 100 volts ac rms and proceed to step "m". To adjust the threshold voltage for an alternative value, adjust the autotransformer to the desired voltage and proceed to step "m".

m. On the power-failure auto-restart card, rotate variable resistor R66 to the center of its range.

n. After 15 minutes equipment warmup time, adjust the oscilloscope for a display of two positive-going pulses. Ensure that the autotransformer output is 100 volts ac rms.

Note

When step "o" is performed, the peak-to-ground amplitude of the pulses may drift beyond the 1.0- to 1.5-volt range after the initial setting. This is a normal condition caused by typical line voltage variations.

o. Adjust variable resistor R66 until the positive peaks of the pulses are 1.0 to 1.5 volts above card ground level (not peak-to-peak) as shown in figure 5-1.

p. Disconnect the oscilloscope leads from the card.

q. Increase the autotransformer output to 115 volts.

r. Press the PRESET switch. The PRESET indicator should turn off. If it does not, repeat steps "k" through "r". When the PRESET indicator turns off, proceed to step "s".

s. Press and release the POWER switch to turn off power.

t. Disconnect test equipment and return computer to normal operation.

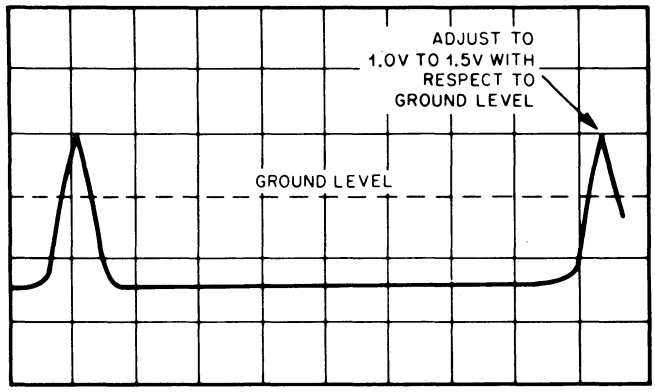


Figure 5-1. Pulse Amplitude at Threshold Voltage

5-13. REFERENCE DESIGNATION INDEX.

5-14. The reference designation index, table 5-1, provides a listing of all electrical parts on the power-failure auto-restart card by their reference designation. The table also provides the HP part number, description, manufacturer's code number, and manufacturer's part number for each part. Abbreviations used in the DESCRIPTION column are listed in table 6-3. Manufacturer's codes are listed in table 6-4.

5-15. MAINTENANCE DIAGRAMS.

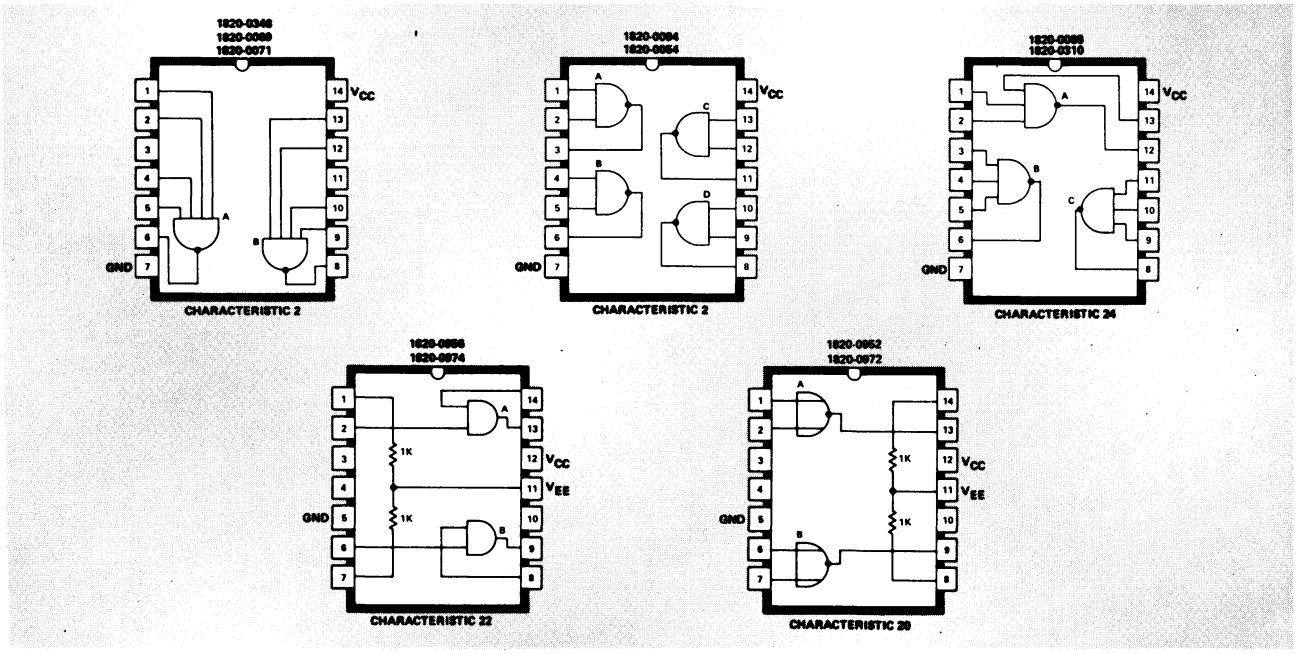
5-16. Maintenance diagrams consisting of microcircuit package diagrams, and a logic diagram with parts location diagram are presented in figures 5-2 and 5-3, respectively.

Table 5-1. Power-Failure Auto-Restart Card (12588-6001) Reference Designation Index

REFERENCE DESIGNATION	HP PART NO.	DESCRIPTION	MFR CODE	MFR PART NO.
C1	0180-1743	Capacitor, Fxd, Elect, 0.1 uF, 10%, 35 VDCW	28480	0180-1743
C2,20	0180-0291	Capacitor, Fxd, Elect, 1.0 uF, 10%, 36 VDCW	28480	0180-0291
C3,4	0150-0121	Capacitor, Fxd, Cer, 0.1 uF, +80 -20%, 50 VDCW	56289	5CS0B15-CML
C5,9	0180-0098	Capacitor, Fxd, Elect, 100 uF, 20%, 20 VDCW	28480	0180-0098
C6	0160-0174	Capacitor, Fxd, Cer, 0.47 uF, +80 -20%, 25 VDCW	56289	5C11B7S-CML
C7	0180-0100	Capacitor, Fxd, Elect, 4.7 uF, 10%, 35 VDCW	28480	0180-0100
C8	0180-1746	Capacitor, Fxd, Elect, 15 uF, 10%, 20 VDCW	28480	0180-1746
C11,12	0180-0097	Capacitor, Fxd, Elect, 47 uF, 10%, 35 VDCW	28480	0180-0097
C13 thru C16, 18,19	0180-0197	Capacitor, Fxd, Elect, 2.2 uF, 10%, 20 VDCW	28480	0180-0197
C17	0180-0141	Capacitor, Fxd, Elect, 50 uF, +75 -10%, 50 VDCW	28480	0180-0141
CR1,3,8,27	1902-3042	Diode, Breakdown, 3.32V, 5%, 400 mW	28480	1902-3042
CR2,12	1902-3224	Diode, Breakdown, 17.8V, 5%, 400 mW	28480	1902-3224
CR4	1902-3152	Diode, Breakdown, 9.31V, 5%	04713	SZ10939-173
CR5,11,13,15,17,18,19,21,22, 25,29	1901-0040	Diode, Si, 30 mA, 30 WV	07263	FDG1088
CR7	1902-3057	Diode, Zener, 3.47V	28480	1902-3057
CR9	1902-3171	Diode, Breakdown, 11.0V, 5%	28480	1902-3171
CR14	1902-0185	Diode, Breakdown, 27.4V, 5%, 400 mW	28480	1902-0185
CR16	1902-0049	Diode, Breakdown, 6.19V, 5%	28480	1902-0049
CR23,24	1901-0045	Diode, Si, 100 PIV	28480	1901-0045
CR26	1902-0071	Diode, Breakdown, 9.0V, 5%	28480	1902-0071
CR28	1902-0048	Diode, Breakdown, 6.81V, 5%	28480	1902-0048
MC16,17,37,76,87	1820-0956	Integrated Circuit, CTL	07263	SL3459
MC26,66,67	1820-0054	Integrated Circuit, TTL	56289	USN7400A
MC36	1820-0094	Integrated Circuit, DTL	07263	U6A994659X
MC46,47	1820-0068	Integrated Circuit, TTL	56289	USN7410A
MC56	1820-0069	Integrated Circuit, TTL	56289	USN7420A
MC57,77	1820-0952	Integrated Circuit, CTL	07263	SL3455
Q1 thru Q8,10,18,19,21,Q23 thru Q25	1854-0215	Transistor, Si, NPN	28480	1854-0215
Q9,11,12,15,16,17,22,26	1853-0036	Transistor, Si, PNP	04713	SP-3612
Q13,14	1854-0071	Transistor, Si, NPN	28480	1854-0071
R1	1810-0020	Resistor Network (7 fxd film resistors)	28480	1810-0020
R2,48	0683-1015	Resistor, Fxd, Comp, 100 ohms, 5%, 1/4W	01121	CB1015
R3,23,25,38,42,53	0683-2225	Resistor, Fxd, Comp, 2.2k, 5%, 1/4W	01121	CB2225
R4,37,61,73,74,86	0683-1025	Resistor, Fxd, Comp, 1000 ohm, 5%, 1/4W	01121	CB1025
R5 thru R7,10,22,24,28,31,32, 39,49,59,62,75,76,79	0683-4715	Resistor, Fxd, Comp, 470 ohm, 5%, 1/4W	01121	CB4715
R8	0683-3305	Resistor, Fxd, Comp, 33 ohms, 5%, 1/4W	01121	CB3305
R9,46	0683-3315	Resistor, Fxd, Comp, 330 ohms, 5%, 1/4W	01121	CB3315
R20	0757-0195	Resistor, Fxd, Flm, 348k, 1%, 1/2W	28480	0757-0195
R21	0698-3405	Resistor, Fxd, Flm, 422 ohms, 1%, 1/2W	28480	0698-3405
R26	0698-3151	Resistor, Fxd, Flm, 2.87k, 1%, 1/8W	28480	0698-3151
R27,29,65,69	0757-0280	Resistor, Fxd, Flm, 1k, 1%, 1/8W	28480	0757-0280
R30	0698-3435	Resistor, Fxd, Flm, 38.3 ohms, 1%, 1/8W	28480	0698-3435
R33	0683-3325	Resistor, Fxd, Comp, 3300 ohms, 5%, 1/4W	01121	CB3325
R34 thru R36	0686-1825	Resistor, Fxd, Comp, 1800 ohms, 5%, 1/2W	01121	EB1825
R40	0686-1515	Resistor, Fxd, Comp, 150 ohms, 5%, 1/2W	01121	EB1515
R43	0757-0805	Resistor, Fxd, Flm, 221 ohms, 1%, 1/2W	28480	0757-0805
R44	0683-1005	Resistor, Fxd, Comp, 10 ohms, 5%, 1/4W	01121	CB1005
R45,47	0698-3628	Resistor, Fxd, met ox, 220 ohms, 5%, 2W	28480	0698-3628
R51	0757-0198	Resistor, Fxd, Flm, 100 ohms, 1%, 1/2W	28480	0698-0198
R52,57	0683-5125	Resistor, Fxd, Comp, 5100 ohms, 5%, 1/4W	01121	CB5125
R54	0683-4745	Resistor, Fxd, Comp, 470k, 5%, 1/4W	01121	CB4745
R55,56	0757-0486	Resistor, Fxd, Flm, 681k, 1%, 1/8W	28480	0757-0485
R58	0683-1035	Resistor, Fxd, Comp, 10k, 5%, 1/4W	01121	CB1035

Table 5-1. Power-Failure Auto-Restart Card (12588-6001) Reference Designation Index (Continued)

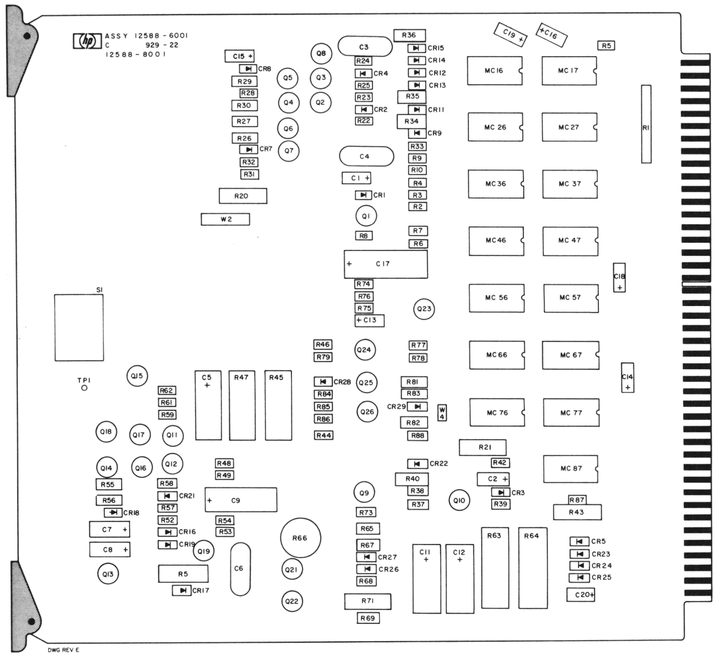
REFERENCE DESIGNATION	HP PART NO.	DESCRIPTION	MFR CODE	MFR PART NO.
R63	0811-0003	Resistor, Fxd, WW, 390 ohms, 1%, 1/4W	28480	0811-0003
R64	0811-2084	Resistor, Fxd, WW, 43 ohms, 1%, 5W	28480	0811-2084
R66	2100-1776	Resistor, Var, WW, lin, 10k, 10%, 1/2W	28480	2100-1776
R67	0757-0442	Resistor, Fxd, Flm, 10.0k, 1%, 1/8W	28480	0757-0442
R71	0757-0808	Resistor, Fxd, Flm, 301 ohms, 1%, 1/4W	28480	0757-0808
R77	0683-6225	Resistor, Fxd, Comp, 6200 ohms, 5%, 1/4W	01121	CB6225
R78	0683-1215	Resistor, Fxd, Comp, 120 ohms, 5%, 1/4W	01121	CB1215
R81	0757-0424	Resistor, Fxd, Flm, 1.10k, 1%, 1/8W	28480	0757-0424
R82	0757-0419	Resistor, Fxd, Flm, 681 ohms, 1%, 1/8W	28480	0757-0419
R83	0698-0084	Resistor, Fxd, Flm, 2.15k, 1%, 1/8W	28480	0698-0084
R84	0683-2725	Resistor, Fxd, Comp, 2700 ohms, 5%, 1/4W	01121	CB2725
R85	0683-2235	Resistor, Fxd, Comp, 22k, 5%, 1/4W	01121	CB2235
R87,88	0683-1525	Resistor, Fxd, Comp, 1500 ohms, 5%, 1/4W	01121	CB1525
S1	3101-0932	Switch, Slide, dpdt, 0.5A, 125V, ac/dc	79727	GG350-0001
W2	5040-1485	Conductor	28480	5040-1485
W4	8159-0005	Jumper Wire	28480	8159-0005



CHARACTERISTIC	INPUT LEVEL		OUTPUT LEVEL		OPEN INPUT ACTS AS:	MAXIMUM PROPAGATION DELAY	
	LOGIC 1 (VOLTS, MIN)	LOGIC 0 (VOLTS, MAX)	LOGIC 1 (VOLTS, MIN)	LOGIC 0 (VOLTS, MAX)		TO LOGIC 1 (NANOSECOND)	TO LOGIC 0 (NANOSECOND)
2	+2.0	+0.8	+2.4	+0.4	Logic 1	29	15
20	+1.5	+0.4	+2.25	-0.3	Logic 0	24	12
22	+1.5	+0.4	+2.2	-0.3	Logic 0	24	24
24	+2.0	+0.9	+2.6	+0.5	Logic 1	80	30

2022-2

Figure 5-2. Microcircuit Package Diagrams



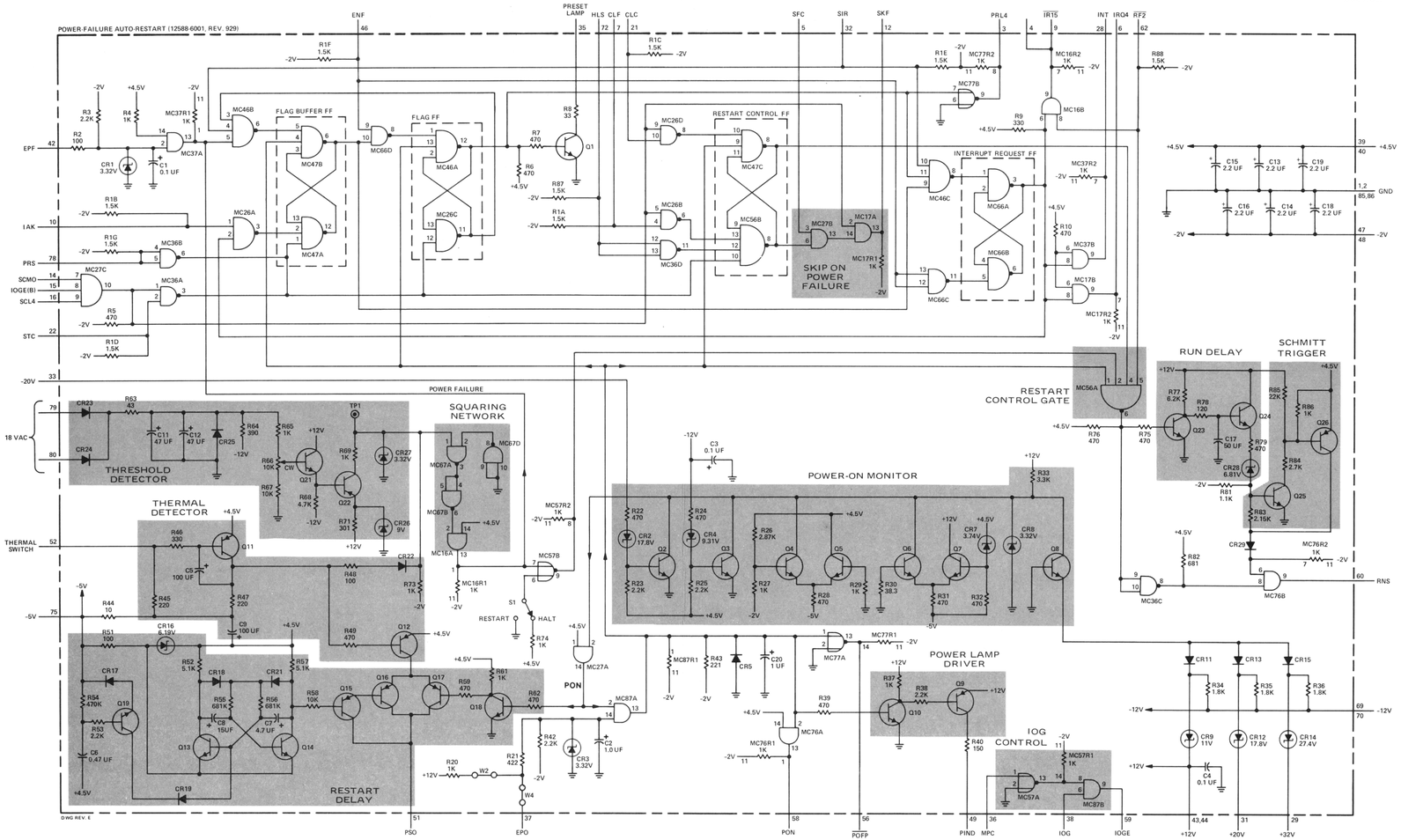


Figure 5-3. Power-Failure Auto-Restart Card (12588-6001) Logic Diagram and Parts Location Diagram

SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for ordering replacement parts for the accessory kit. Table 6-1 is a total quantity listing of all items supplied in the kit and table 6-2 is a total quantity listing of all replaceable parts on the power-failure auto-restart card. The parts in tables 6-1 and 6-2 are listed in numerical order by part number.

6-3. A reference designation index and parts location diagram for the power-failure auto-restart card are provided in section V of this manual, adjacent to the logic diagram for the card.

6-4. Tables 5-1, 6-1, and 6-2 list the following information for each part:

a. Reference designation of the part (table 5-1 only).

b. Hewlett-Packard part number.

c. Description of the part. (Refer to table 6-3 for an explanation of abbreviations in the DESCRIPTION column.)

d. A five-digit code that corresponds to the manufacturer of the part. (Refer to table 6-4 for a list of the manufacturers that correspond to the codes.)

e. Manufacturer's part number.

f. Total quantity of each part used in the kit or assembly (tables 6-1 and 6-2 only).

6-5. ORDERING INFORMATION.

6-6. To order replacement parts, address the order or inquiry to the local Hewlett-Packard Sales and Service Office. (Refer to list at the end of this manual for addresses.) Specify the following information for each part ordered:

a. Instrument model and serial number.

b. Hewlett-Packard part number for each part.

c. Description of each part.

d. Circuit reference designation (if applicable).

Table 6-1. 12588A Accessory Kit Replaceable Parts

HP PART NO.	DESCRIPTION	MFR CODE	MFR PART NO.	TQ
12588-6001	Power-Failure Auto-Restart Card (see figure 5-3)	28480	12588-6001	1
12588-9002	Operating and Service Manual	28480	12588-9002	1

Table 6-2. Power-Failure Auto-Restart Card (12588-6001) Replaceable Parts

HP PART NO.	DESCRIPTION	MFR CODE	MFR PART NO.	TQ
0150-0121	Capacitor, Fxd, Cer, 0.1 uF, +80 -20%, 50 VDCW	56289	5C50BIS-CML	2
0160-0174	Capacitor, Fxd, Cer, 0.47 uF, +80 -20%, 25 VDCW	56289	5C11B7S-CML	1
0180-0097	Capacitor, Fxd, Elect, 47 uF, 10%, 35 VDCW	28480	0180-0097	2
0180-0098	Capacitor, Fxd, Elect, 100 uF, 20%, 20 VDCW	28480	0180-0098	2
0180-0100	Capacitor, Fxd, Elect, 4.7 uF, 10%, 35 VDCW	28480	0180-0100	1
0180-0141	Capacitor, Fxd, Elect, 50 uF, +75 -10%, 50 VDCW	28480	0180-0141	1
0180-0197	Capacitor, Fxd, Elect, 2.2 uF, 10%, 20 VDCW	28480	0180-0197	6
0180-0291	Capacitor, Fxd, Elect, 1.0 uF, 10%, 35 VDCW	28480	0180-0291	2
0180-1743	Capacitor, Fxd, Elect, 0.7 uF, 10%, 35 VDCW	28480	0180-1743	1
0180-1746	Capacitor, Fxd, Elect, 15 uF, 10%, 20 VDCW	28480	0180-1746	1
0683-1005	Resistor, Fxd, Comp, 10 ohms, 5%, 1/4W	01121	CB1005	1
0683-1015	Resistor, Fxd, Comp, 100 ohms, 5%, 1/4W	01121	CB1015	2
0683-1025	Resistor, Fxd, Comp, 1000 ohms, 5%, 1/4W	01121	CB1025	6
0683-1035	Resistor, Fxd, Comp, 10k, 5%, 1/4W	01121	CB1035	1
0683-1215	Resistor, Fxd, Comp, 120 ohms, 5%, 1/4W	01121	CB1215	1
0683-1525	Resistor, Fxd, Comp, 1500 ohms, 5%, 1/4W	01121	CB1525	2
0683-2225	Resistor, Fxd, Comp, 2.2k ohms, 5%, 1/4W	01121	GB2225	6
0683-2235	Resistor, Fxd, Comp, 22k ohms, 5%, 1/4W	01121	CB2235	1
0683-2725	Resistor, Fxd, Comp, 2700 ohms, 5%, 1/4W	01121	CB2725	1
0683-3305	Resistor, Fxd, Comp, 33 ohms, 5%, 1/4W	01121	CB3305	1
0683-3315	Resistor, Fxd, Comp, 330 ohms, 5%, 1/4W	01121	CB3315	2
0683-3325	Resistor, Fxd, Comp, 3300 ohms, 5%, 1/4W	01121	CB3325	1
0683-4715	Resistor, Fxd, Comp, 470 ohms, 5%, 1/4W	01121	CB4715	16
0683-4725	Resistor, Fxd, Comp, 4700 ohms, 5%, 1/4W	01121	CB4725	1
0683-4745	Resistor, Fxd, Comp, 470k ohms, 5%, 1/4W	01121	CB4745	1
0683-5125	Resistor, Fxd, Comp, 5100 ohms, 5%, 1/4W	01121	CB5125	2
0683-6225	Resistor, Fxd, Comp, 6200 ohms, 5%, 1/4W	01121	CB6225	1
0686-1515	Resistor, Fxd, Comp, 150 ohms, 5%, 1/2W	01121	EB1515	1
0686-1825	Resistor, Fxd, Comp, 1800 ohms, 5%, 1/2W	01121	EB1825	3
0698-0084	Resistor, Fxd, Flm, 2.15k, 1%, 1/8W	28480	0698-0084	1
0698-3151	Resistor, Fxd, Flm, 2.87k, 1%, 1/8W	28480	0698-3151	1
0698-3405	Resistor, Fxd, Flm, 422 ohms, 1%, 1/2W	28480	0698-3405	1
0698-3435	Resistor, Fxd, Flm, 38.3 ohms, 1%, 1/8W	28480	0698-3435	1
0698-3628	Resistor, Fxd, met ox, 220 ohms, 5%, 2W	28480	0698-3628	2
0757-0195	Resistor, Fxd, Flm, 348K, 1%, 1/2W	28480	0757-0195	1
0757-0198	Resistor, Fxd, Flm, 100 ohms, 1%, 1/2W	28480	0757-0198	1
0757-0280	Resistor, Fxd, Flm, 1k, 1%, 1/8W	28480	0757-0280	4
0757-0419	Resistor, Fxd, Flm, 681 ohms, 1%, 1/8W	28480	0757-0419	1
0757-0424	Resistor, Fxd, Flm, 1.10k, 1%, 1/8W	28480	0757-0424	1
0757-0442	Resistor, Fxd, Flm, 10.0k, 1%, 1/8W	28480	0757-0442	1
0757-0485	Resistor, Fxd, Flm, 681k, 1%, 1/8W	28480	0757-0485	2
0757-0805	Resistor, Fxd, Flm, 221 ohms, 1%, 1/2W	28480	0757-0805	1
0757-0808	Resistor, Fxd, Flm, 301 ohms, 1%, 1/4W	28480	0757-0808	1
0811-0003	Resistor, Fxd, WW, 390 ohms, 1%, 1/4W	28480	0811-0003	1
0811-2084	Resistor, Fxd, WW, 43 ohms, 1%, 5W	28480	0811-2084	1
1480-0116	Pin, PC Extractor	28480	1480-0116	2
1810-0020	Resistor Network (7 fxd flm resistors)	28480	1810-0020	1
1820-0054	Integrated Circuit, TTL	56289	USN7400A	3
1820-0068	Integrated Circuit, TTL	56289	USN7410A	2
1820-0069	Integrated Circuit, TTL	56289	USN7420A	1

Table 6-2. Power-Failure Auto-Restart Card (12588-6001) Replaceable Parts (Continued)

HP PART NO.	DESCRIPTION	MFR CODE	MFR PART NO.	TQ
1820-0094	Integrated Circuit, DTL	07263	U6A994659X	1
1820-0952	Integrated Circuit, CTL	07263	SL3455	2
1820-0956	Integrated Circuit, CTL	07263	SL3459	5
1853-0036	Transistor, Silicon, PNP	04713	SP-3612	8
1854-0071	Transistor, Silicon, NPN	28480	1854-0071	2
1854-0215	Transistor, Silicon, NPN	28480	1854-0215	15
1901-0040	Diode, Silicon, 30 mA, 30 WV	07263	FDG1088	11
1901-0045	Diode, Silicon, 100 PIV	28480	1901-0045	2
1902-0048	Diode, Breakdown, 6.81V, 5%	28480	1902-0048	1
1902-0049	Diode, Breakdown, 6.19V, 5%	28480	1902-0049	1
1902-0071	Diode, Breakdown, 9.0V, 5%	28480	1902-0071	1
1902-0185	Diode, Breakdown, 27.4V, 5%, 400 mW	28480	1902-0185	1
1902-3042	Diode, Breakdown, 5%, 3.32V, 400 mW	28480	1902-3042	4
1902-3057	Diode, Zener, 3.47V	28480	1902-3057	1
1902-3152	Diode, Breakdown, 9.31V, 5%	04713	SZ10939-173	1
1902-3171	Diode, Breakdown, 11.0V, 5%	28480	1902-3171	1
1902-3224	Diode, Breakdown, 17.8V, 5%, 400 mn	28480	1902-3224	2
2100-1776	Resistor, Var, WW, lin, 10k, 10%, 1/2W	28480	2100-1776	1
3101-0932	Switch, Slide, dpdt, 0.5A, 125V, ac/dc	79727	GG350-0001	1
5040-1464	PC Extractor	28480	5040-1464	2
5040-1485	Conductor	28480	5040-1485	1
8159-0005	Jumper Wire	28480	8159-0005	1

Table 6-3. Reference Designations and Abbreviations

REFERENCE DESIGNATIONS

A	= assembly	K	= relay	TB	= terminal board
B	= motor	L	= inductor	TP	= test point
BT	= battery	M	= meter	U	= integrated circuit
C	= capacitor	MC	= microcircuit	V	= vacuum tube, neon bulb, photocell, etc.
CR	= diode	P	= plug connector		
DL	= delay line	Q	= transistor	VR	= voltage regulator
DS	= indicator (lamp)	R	= resistor	W	= cable, jumper
E	= misc hardware	RT	= thermistor	X	= socket
F	= fuse	S	= switch	Y	= crystal
FL	= filter	T	= transformer	Z	= tuned cavity, network
J	= receptacle connector				

ABBREVIATIONS

A	= amperes	gnd	= ground(ed)	ph	= Phillips head
ac	= alternating current	gra	= gray	pk	= peak
ad	= anode	grn	= green	p-p	= peak-to-peak
Al	= aluminum			pt	= point
AR	= as required	H	= henries	PIV	= peak inverse voltage
adj	= adjust	Hg	= mercury	PNP	= positive-negative-positive
Assy	= assembly	hr	= hour(s)	PWV	= peak working voltage
		Hz	= hertz	porc	= porcelain
B	= base	hdw	= hardware	posn	= position(s)
bp	= bandpass	hex	= hexagon, hexagonal	pozi	= pozidrive
bfo	= beat frequency oscillator			ph brz	= phosphor bronze
blk	= black	ID	= inside diameter		
blu	= blue	IF	= intermediate frequency	rf	= radio frequency
brn	= brown	in.	= inch, inches	rdh	= round head
brs	= brass	I/O	= input/output	rmo	= rack mount only
Btu	= British thermal unit	int	= internal	rms	= root-mean-square
bwc	= backward wave oscillator	incl	= include(s)	RWV	= reverse working voltage
Be Cu	= beryllium copper	insul	= insulation, insulated	rect	= rectifier
		impgrg	= impregnated	r/min	= revolutions per minute
C	= collector	incand	= incandescent		
cw	= clockwise			s	= second
ccw	= counterclockwise	k	= kilo (10^3), kilohm	SB	= slow-blow
cer	= ceramic			Se	= selenium
cmo	= cabinet mount only	lp	= low pass	Si	= silicon
com	= common			scr	= silicon-controlled rectifier
crt	= cathode-ray tube	m	= milli (10^{-3})	sil	= silver
CTL	= capacitor-transistor logic	M	= mega (10^6), megohm	sst	= stainless steel
cath	= cathode	My	= Mylar	stl	= steel
cd pl	= cadmium plate	mfr	= manufacturer	spcl	= special
Comp	= composition	mom	= momentary	spdt	= single-pole, double-throw
conn	= connector	mtg	= mounting	spst	= single-pole, single-throw
compl	= complete	misc	= miscellaneous	semicond	= semiconductor
		met ox	= metal oxide		
dc	= direct current	mintr	= miniature	Ta	= tantalum
dr	= drive			td	= time delay
DTL	= diode-transistor logic	n	= nano (10^{-9})	Ti	= titanium
depc	= deposited carbon	nc	= normally closed or no connection	tgl	= toggle
dpdt	= double-pole, double-throw			thd	= thread
dpst	= double-pole, single-throw	Ne	= neon	tol	= tolerance
		no.	= number or normally open	TTL	= transistor-transistor logic
E	= emitter	np	= nickel plated	term	= terminal
ext	= external	NPN	= negative-positive-negative		
encap	= encapsulated	NPO	= negative positive zero (zero temperature coefficient)	U (μ)	= micro (10^{-6})
elctlt	= electrolytic				
		NSR	= not separately replaceable	V	= volt(s)
F	= farads	NRFR	= not recommended for field replacement	var	= variable
FF	= flip-flop			vio	= violet
flh	= flat head			VDCW	= direct current working volts
flm	= film	OD	= outside diameter		
fxd	= fixed	OBD	= order by description	W	= watts
filh	= fillister head	orn	= orange	ww	= wirewound
		ovh	= oval head	wht	= white
G	= giga (10^9)	oxd	= oxide	WIV	= working inverse voltage
Ge	= germanium				
gl	= glass	p	= pico (10^{-12})	yel	= yellow
		PC	= printed circuit		

Table 6-4. Code List of Manufacturers

The following code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbooks H4-1 (Name to Code) and H4-2 (Code to Name) and their latest supplements. The date of revision and the date of the supplements used appear at the bottom of each page. Alphabetical codes have been arbitrarily assigned to suppliers not appearing in the H4 Handbooks.

Code No.	Manufacturer	Address
00000	U.S.A. Common	Any supplier of U.S.
00136	McCoy Electronics	Mount Holly Springs, Pa.
00213	Sage Electronics Corp.	Rochester, N.Y.
00287	Cemco Inc.	Danielson, Conn.
00334	Humidial	Colton, Calif.
00348	Microtron Co., Inc.	Valley Stream, N.Y.
00373	Garlock Inc.	Cherry Hill, N.J.
00656	Aerovox Corp.	New Bedford, Mass.
00779	Amp. Inc.	Harrisburg, Pa.
00781	Aircraft Radio Corp.	Boonton, N.J.
00815	Northern Engineering Laboratories, Inc.	Burlington, Wis.
00853	Sangamo Electric Co., Pickens Div.	Pickens, S.C.
00866	Goe Engineering Co.	City of Industry, Cal.
00891	Carl E. Holmes Corp.	Los Angeles, Calif.
00929	Microlab Inc.	Livingston, N.J.
01002	General Electric Co., Capacitor Dept.	Hudson Falls, N.Y.
01009	Alden Products Co.	Brockton, Mass.
01121	Allen Bradley Co.	Milwaukee, Wis.
01255	Litton Industries, Inc.	Beverly Hills, Calif.
01281	TRW Semiconductors, Inc.	Lawndale, Calif.
01295	Texas Instruments, Inc., Transistor Products Div.	Dallas, Texas
01349	The Alliance Mfg. Co.	Alliance, Ohio
01589	Pacific Relays, Inc.	Van Nuys, Calif.
01670	Gudebrod Bros. Silk Co.	New York, N.Y.
01930	Amerock Corp.	Rockford, Ill.
01961	Pulse Engineering Co.	Santa Clara, Calif.
02114	Ferroxcube Corp. of America	Saugerties, N.Y.
02116	Wheelock Signals, Inc.	Long Branch, N.J.
02286	Cole Rubber and Plastics Inc.	Sunnyvale, Calif.
02660	Amphenol-Borg Electronics Corp.	Broadview, Ill.
02735	Radio Corp. of America, Semiconductor and Materials Div.	Somerville, N.J.
02771	Vocaline Co. of America, Inc.	Old Saybrook, Conn.
02777	Hopkins Engineering Co.	San Fernando, Calif.
02875	Hudson Tool & Die Co.	Newark, N.J.
03508	G.E. Semiconductor Prod. Dept.	Syracuse, N.Y.
03705	Apex Machine & Tool Co.	Dayton, Ohio
03797	Eldema Corp.	Compton, Calif.
03818	Parker Seal Co.	Los Angeles, Calif.
03877	Transitron Electric Corp.	Wakefield, Mass.
03888	Pyrofilm Resistor Co., Inc.	Cedar Knolls, N.J.
03954	Singer Co., Diehl Div. Finderne Plant	Sumerville, N.J.
04009	Arrow, Hart and Hegeman Elect. Co.	Hartford, Conn.
04013	Taurus Corp.	Lambertville, N.J.
04062	Arco Electronic Inc.	Great Neck, N.Y.
04222	Hi-Q Division of Aerovox	Myrtle Beach, S.C.
04354	Precision Paper Tube Co.	Wheeling, Ill.
04404	Dymec Division of Hewlett-Packard Co.	Palo Alto, Calif.
04651	Sylvania Electric Products, Microwave Device Div.	Mountain View, Calif.
04673	Dakota Engr. Inc.	Culver City, Calif.
04713	Motorola, Inc., Semiconductor Prod. Div.	Phoenix, Arizona
04732	Filtron Co., Inc. Western Div.	Culver City, Calif.
04773	Automatic Electric Co.	Northlake, Ill.
04796	Sequoia Wire Co.	Redwood City, Calif.
04811	Precision Coil Spring Co.	El Monte, Calif.
04870	P.M. Motor Company	Westchester, Ill.
04919	Component Mfg. Service Co.	W. Bridgewater, Mass.
05006	Twentieth Century Plastics, Inc.	Los Angeles, Calif.
05245	Components Corp.	Chicago, Ill.
05277	Westinghouse Electric Corp. Semi-Conductor Dept.	Youngwood, Pa.
05347	Ultronix, Inc.	San Mateo, Calif.
05397	Union Carbide Corp., Elect. Div.	New York, N.Y.
05574	Viking Ind. Inc.	Canoga Park, Calif.
05593	Icore Electro-Plastics Inc.	Sunnyvale, Calif.
05616	Cosmo Plastic (c/o Electrical Spec. Co.)	Cleveland, Ohio
05624	Barber Colman Co.	Rockford, Ill.
05728	Tiffen Optical Co.	Roslyn Heights, Long Island, N.Y.
05729	Metro-Tel Corp.	Westbury, N.Y.
05783	Stewart Engineering Co.	Santa Cruz, Calif.
05820	Wakefield Engineering Inc.	Wakefield, Mass.
06004	Bassick Co., Div. of Stewart Warner Corp.	Bridgeport, Conn.
06090	Raychem Corp.	Redwood City, Calif.
06175	Bausch and Lomb Optical Co.	Rochester, N.Y.
06402	E.T.A. Products Co. of America	Chicago, Ill.
06540	Amatom Electronic Hardware Co., Inc.	New Rochelle, N.Y.
06555	Beede Electrical Instrument Co., Inc.	Penacook, N.H.
06666	General Devices Co., Inc.	Indianapolis, Ind.
06751	Components Inc., Ariz. Div.	Phoenix, Ariz.
06812	Torrington Mfg. Co., West Div.	Van Nuys, Calif.
06980	Varian Assoc. Eimac Div.	San Carlos, Calif.
07088	Kelvin Electric Co.	Van Nuys, Calif.
07126	Digitran Co.	Pasadena, Calif.
07137	Transistor Electronics Corp.	Minneapolis, Minn.
07138	Westinghouse Electric Corp. Electronic Tube Div.	Elmira, N.Y.
07149	Filmohm Corp.	New York, N.Y.
07233	Cinch-Graphik Co.	City of Industry, Calif.
07256	Silicon Transistor Corp.	Carle Place, N.Y.
07261	Avnet Corp.	Culver City, Calif.
07263	Fairchild Camera & Inst. Corp. Semiconductor Div.	Mountain View, Calif.
07322	Minnesota Rubber Co.	Minneapolis, Minn.
07387	Birtcher Corp., The	Monterey Park, Calif.
07397	Sylvania Elect. Prod. Inc., Mt. View Operations	Mountain View, Calif.
07700	Technical Wire Products Inc.	Cranford, N.J.
07829	Bodine Elect. Co.	Chicago, Ill.
07910	Continental Device Corp.	Hawthorne, Calif.
07933	Raytheon Mfg. Co., Semiconductor Div.	Mountain View, Calif.
07980	Hewlett-Packard Co., Boonton Radio Div.	Rockaway, N.J.
08145	U.S. Engineering Co.	Los Angeles, Calif.
08289	Blinn, Delbert Co.	Pomona, Calif.
08358	Burgess Battery Co.	Niagara Falls, Ontario, Canada
08524	Deutsch Fastener Corp.	Los Angeles, Calif.
08664	Bristol Co., The	Waterbury, Conn.
08717	Sloan Company	Sun Valley, Calif.
08718	ITT Cannon Electric Inc., Phoenix Div.	Phoenix, Arizona
08727	National Radio Lab. Inc.	Paramus, N.J.
08792	CBS Electronics Semiconductor Operations, Div of C.B.S. Inc.	Lowell, Mass.
08806	General Electric Co. Miniat. Lamp Dept.	Cleveland, Ohio
08984	Mel-Rain	Indianapolis, Ind.
09026	Babcock Relays Div.	Costa Mesa, Calif.
09134	Texas Capacitor Co.	Houston, Texas
09145	Tech. Ind. Inc. Atohm Elect.	Burbank, Calif.
09250	Electro Assemblies, Inc.	Chicago, Ill.
09353	C & K Components Inc.	Newton, Mass.
09569	Mallory Battery Co. of Canada, Ltd.	Toronto, Ontario, Canada
09922	Burndy Corp.	Norwalk, Conn.
10214	General Transistor Western Corp.	Los Angeles, Calif.
10411	Ti-Tal, Inc.	Berkeley, Calif.
10646	Carborundum Co.	Niagara Falls, N.Y.
11236	CTS of Berne, Inc.	Berne, Ind.
11237	Chicago Telephone of California, Inc.	So. Pasadena, Calif.
11242	Bay State Electronics Corp.	Waltham, Mass.
11312	Teledyne Inc., Microwave Div.	Palo Alto, Calif.
11314	National Seal	Downey, Calif.
11453	Precision Connector Corp.	Jamaica, N.Y.
11534	Duncan Electronics Inc.	Costa Mesa, Calif.
11711	General Instrument Corp., Semiconductor Div., Products Group	Newark, N.J.
11717	Imperial Electronic, Inc.	Buena Park, Calif.
11870	Melabs, Inc.	Palo Alto, Calif.
12040	National Semiconductor	Danbury, Conn.
12136	Philadelphia Handle Co.	Camden, N.J.
12361	Grove Mfg. Co., Inc.	Shady Grove, Pa.
12574	Gulton Ind. Inc. Data System Div.	Albuquerque, N.M.
12697	Clarostat Mfg. Co.	Dover, N.H.
12728	Elmar Filter Corp.	W. Haven, Conn.
12859	Nippon Electric Co., Ltd.	Tokyo, Japan
12881	Metex Electronics Corp.	Clark, N.J.
12930	Delta Semiconductor Inc.	Newport Beach, Calif.
12954	Dickson Electronics Corp.	Scottsdale, Arizona
13103	Thermolloy	Dallas, Texas
13396	Telefunken (GmbH)	Hanover, Germany
13835	Midland-Wright Div. of Pacific Industries, Inc.	Kansas City, Kansas
14099	Sem-Tech	Newbury Park, Calif.
14193	Calif. Resistor Corp.	Santa Monica, Calif.
14298	American Components, Inc.	Conshohocken, Pa.
14433	ITT Semiconductor, A Div. of Int. Telephone & Telegraph Corp.	West Palm Beach, Fla.
14493	Hewlett-Packard Company	Loveland, Colo.
14655	Cornell Dublier Electric Corp.	Newark, N.J.
14674	Corning Glass Works	Corning, N.Y.
14752	Electro Cube Inc.	San Gabriel, Calif.
14960	Williams Mfg. Co.	San Jose, Calif.
15203	Webster Electronics Co.	New York, N.Y.
15287	Scionics Corp.	Northridge, Calif.
15291	Adjustable Bushing Co.	N. Hollywood, Calif.
15558	Micron Electronics	Garden City, Long Island, N.Y.
15566	Amprobe Inst. Corp.	Lynbrook, N.Y.
15631	Cabletronics	Costa Mesa, Calif.
15772	Twentieth Century Coil Spring Co.	Santa Clara, Calif.
15801	Fenwal Elect. Inc.	Framingham, Mass.
15818	Amelco Inc.	Mt. View, Calif.
16037	Spruce Pine Mica Co.	Spruce Pine, N.C.
16179	Omni-Spectra Inc.	Farmington, Mich.
16352	Computer Diode Corp.	Lodi, N.J.
16585	Boots Aircraft Nut Corp.	Pasadena, Calif.
16688	Ideal Prec. Meter Co., Inc. De Jur Meter Div.	Brooklyn, N.Y.
16758	Delco Radio Div. of G.M. Corp.	Kokoma, Ind.
17109	Thermonetics Inc.	Canoga Park, Calif.
17474	Tranex Company	Mountain View, Calif.
17554	Components Inc.	Biddeford, Ma.
17675	Hamlin Metal Products Corp.	Akron, Ohio
17745	Angstrohm Prec. Inc.	No. Hollywood, Calif.

Table 6-4. Code List of Manufacturers (Continued)

Code No.	Manufacturer	Address
17870	McGraw-Edison Co.	Manchester, N.H.
18042	Power Design Pacific Inc.	Palo Alto, Calif.
18083	Clevite Corp., Semiconductor Div.	Palo Alto, Calif.
18324	Signetics Corp.	Sunnyvale, Calif.
18476	Ty-Car Mfg. Co., Inc.	Holliston, Mass.
18486	TRW Elect. Comp. Div.	Des Plaines, Ill.
18583	Curtis Instrument, Inc.	Mt. Kisco, N.Y.
18612	Vishay Instruments Inc.	Malvern, Pa.
18873	E.I. DuPont and Co., Inc.	Wilmington, Del.
18911	Durant Mfg. Co.	Milwaukee, Wis.
19315	The Bendix Corp., Navigation & Control Div.	Teterboro, N.J.
19500	Thomas A. Edison Industries, Div. of McGraw-Edison Co.	West Orange, N.J.
19589	Concoa	Baldwin Park, Calif.
19644	LRC Electronics	Horseheads, N.Y.
19701	Electra Mfg. Co.	Independence, Kansas
20183	General Atronics Corp.	Philadelphia, Pa.
21226	Executone, Inc.	Long Island City, N.Y.
21335	Fafnir Bearing Co., The	New Britain, Conn.
21520	Fansteel Metallurgical Corp.	N. Chicago, Ill.
23042	Texscan Corp.	Indianapolis, Ind.
23783	British Radio Electronics Ltd.	Washington, D.C.
24455	G.E. Lamp Division	Nela Park, Cleveland, Ohio
24655	General Radio Co.	West Concord, Mass.
24681	Memcor Inc., Comp. Div.	Huntington, Ind.
24796	Parelco Inc.	San Juan Capistrano, Calif.
26365	Gries Reproducer Corp.	New Rochelle, N.Y.
26462	Grobet File Co. of America, Inc.	Carlstadt, N.J.
26851	Compac/Hollister Co.	Hollister, Calif.
26992	Hamilton Watch Co.	Lancaster, Pa.
27251	Specialities Mfg. Co., Inc.	Stratford, Conn.
28480	Hewlett-Packard Co.	Palo Alto, Calif.
28520	Heyman Mfg. Co.	Kenilworth, N.J.
30817	Instrument Specialties Co., Inc.	Little Falls, N.J.
33173	G.E. Receiving Tube Dept.	Owensboro, Ky.
35434	Lectrohm Inc.	Chicago, Ill.
36196	Stanwyck Coil Products Ltd.	Hawkesbury, Ontario, Canada
36287	Cunningham, W.H. & Hill, Ltd.	Toronto Ontario, Canada
37942	P.R. Mallory & Co. Inc.	Indianapolis, Ind.
39543	Mechanical Industries Prod. Co.	Akron, Ohio
40920	Miniature Precision Bearings, Inc.	Keene, N.H.
42190	Muter Co.	Chicago, Ill.
43990	C.A. Norgren Co.	Englewood, Colo.
44655	Ohmite Mfg. Co.	Skokie, Ill.
46384	Penn Eng. & Mfg. Corp.	Doylestown, Pa.
47904	Polaroid Corp.	Cambridge, Mass.
48620	Precision Thermometer & Inst. Co.	Southampton, Pa.
49956	Microwave & Power Tube Div.	Waltham, Mass.
52090	Rowan Controller Co.	Westminster, Md.
52983	Sanborn Company	Waltham, Mass.
54294	Shallcross Mfg. Co.	Selma, N.C.
55026	Simpson Electric Co.	Chicago, Ill.
55933	Sonotone Corp.	Elmsford, N.Y.
55938	Raytheon Co. Commercial Apparatus & Systems Div.	So. Norwalk, Conn.
56137	Spaulding Fibre Co., Inc.	Tonawanda, N.Y.
56289	Sprague Electric Co.	North Adams, Mass.
59446	Telex Corp.	Tulsa, Okla.
59730	Thomas & Betts Co.	Elizabeth, N.J.
60741	Triplett Electrical Inst. Co.	Bluffton, Ohio
61775	Union Switch and Signal, Div. of Westinghouse Air Brake Co.	Pittsburgh, Pa.
62119	Universal Electric Co.	Owosso, Mich.
63743	Ward-Leonard Electric Co.	Mt. Vernon, N.Y.
64959	Western Electric Co., Inc.	New York, N.Y.
65092	Weston Inst. Inc. Weston-Newark	Newark, N.J.
66295	Wittek Mfg. Co.	Chicago, Ill.
66346	Minnesota Mining & Mfg. Co. Revere Mincom Div.	St. Paul, Minn.
70276	Allen Mfg. Co.	Hartford, Conn.
70309	Allied Control	New York, N.Y.
70318	Allmetal Screw Product Co., Inc.	Garden City, N.Y.
70417	Amplex, Div. of Chrysler Corp.	Detroit, Mich.
70485	Atlantic India Rubber Works, Inc.	Chicago, Ill.
70563	Amperite Co., Inc.	Union City, N.J.
70674	ADC Products Inc.	Minneapolis, Minn.
70903	Belden Mfg. Co.	Chicago, Ill.
70998	Bird Electronic Corp.	Cleveland, Ohio
71002	Birnbach Radio Co.	New York, N.Y.
71034	Bliley Electric Co., Inc.	Erie, Pa.
71041	Boston Gear Works Div. of Murray Co. of Texas	Quincy, Mass.
71218	Bud Radio, Inc.	Willoughby, Ohio
71279	Cambridge Thermionics Corp.	Cambridge, Mass.
71286	Camloc Fastener Corp.	Paramus, N.J.
71313	Cardwell Condenser Corp.	Lindenhurst L.I., N.Y.
71400	Bussmann Mfg. Div. of McGraw-Edison Co.	St. Louis, Mo.
71436	Chicago Condenser Corp.	Chicago, Ill.
71447	Calif. Spring Co., Inc.	Pico-Rivera, Calif.
71450	CTS Corp.	Elkhart, Ind.
71468	ITT Cannon Electric Inc.	Los Angeles, Calif.
71471	Cinema, Div. Aerovox Corp.	Burbank, Calif.
71482	C.P. Clare & Co.	Chicago, Ill.
71590	Centralab Div. of Globe Union Inc.	Milwaukee, Wis.
71616	Commercial Plastics Co.	Chicago, Ill.
71700	Cornish Wire Co., The	New York, N.Y.
71707	Coto Coil Co., Inc.	Providence, R.I.
71744	Chicago Miniature Lamp Works	Chicago, Ill.
71785	Cinch Mfg. Co., Howard B. Jones Div.	Chicago, Ill.
71984	Dow Corning Corp.	Midland, Mich.
72136	Electro Motive Mfg. Co., Inc.	Willimantic, Conn.
72619	Dialight Corp.	Brooklyn, N.Y.
72656	Indiana General Corp., Electronics Div.	Keasby, N.J.
72699	General Instrument Corp., Cap. Div.	Newark, N.J.
72765	Drake Mfg. Co.	Harwood Heights, Ill.
72825	Hugh H. Eby Inc.	Philadelphia, Pa.
72928	Gudeman Co.	Chicago, Ill.
72962	Elastic Stop Nut Corp.	Union, N.J.
72964	Robert M. Hadley Co.	Los Angeles, Calif.
72982	Erie Technological Products, Inc.	Erie, Pa.
73061	Hansen Mfg. Co., Inc.	Princeton, Ind.
73076	H.M. Harper Co.	Chicago, Ill.
73138	Helipot Div. of Beckman Inst., Inc.	Fullerton, Calif.
73293	Hughes Products Division of Hughes Aircraft Co.	Newport Beach, Calif.
73445	Amperex Elect Co.	Hicksville, L.I., N.Y.
73506	Bradley Semiconductor Corp.	New Haven, Conn.
73559	Carling Electric, Inc.	Hartford, Conn.
73586	Circle F Mfg. Co.	Trenton, N.J.
73682	George K. Garrett Co., Div. MSL Industries Inc.	Philadelphia, Pa.
73734	Federal Screw Products Inc.	Chicago, Ill.
73743	Fischer Special Mfg. Co.	Cincinnati, Ohio
73793	General Industries Co., The	Elyria, Ohio
73846	Goshen Stamping & Tool Co.	Goshen, Ind.
73899	JFD Electronics Corp.	Brooklyn, N.Y.
73905	Jennings Radio Mfg. Corp.	San Jose, Calif.
73957	Groov-Pin Corp.	Ridgefield, N.J.
74276	Signalite Inc.	Neptune, N.J.
74455	J.H. Winns, and Sons	Winchester, Mass.
74861	Industrial Condenser Corp.	Chicago, Ill.
74868	R.F. Products Division of Amphenol-Borg Electronics Corp.	Danbury, Conn.
74970	E.F. Johnson Co.	Waseca, Minn.
75042	International Resistance Co.	Philadelphia, Pa.
75263	Keystone Carbon Co., Inc.	St. Marys, Pa.
75378	CTS Knights Inc.	Sandwich, Ill.
75382	Kulka Electric Corporation	Mt. Vernon, N.Y.
75818	Lenz Electric Mfg. Co.	Chicago, Ill.
75915	Littlefuse, Inc.	Des Plaines, Ill.
76005	Lord Mfg. Co.	Erie, Pa.
76210	C.W. Marwedel	San Francisco, Calif.
76433	General Instrument Corp., Micamold Division	Newark, N.J.
76487	James Millen Mfg. Co., Inc.	Malden, Mass.
76493	J.W. Miller Co.	Los Angeles, Calif.
76530	Cinch-Monadnock, Div. of United Carr Fastener Corp.	San Leandro, Calif.
76545	Mueller Electric Co.	Cleveland, Ohio
76703	National Union	Newark, N.J.
76854	Oak Manufacturing Co.	Crystal Lake, Ill.
77068	The Bendix Corp., Electrodynamics Div.	N. Hollywood, Calif.
77075	Pacific Metals Co.	San Francisco, Calif.
77221	Phanostran Instrument and Electronic Co.	South Pasadena, Calif.
77252	Philadelphia Steel and Wire Corp.	Philadelphia, Pa.
77342	American Machine & Foundry Co. Potter & Brumfield Div.	Princeton, Ind.
77630	TRW Electronic Components Div.	Camden, N.J.
77638	General Instrument Corp., Rectifier Div.	Brooklyn, N.Y.
77764	Resistance Products Co.	Harrisburg, Pa.
77969	Rubbercraft Corp. of Calif.	Torrance, Calif.
78189	Shakeproof Division of Illinois Tool Works	Elgin, Ill.
78277	Sigma	So. Braintree, Mass.
78283	Signal Indicator Corp.	New York, N.Y.
78290	Struthers-Dunn Inc.	Pitman, N.J.
78424	Speciality Leather Prod. Co.	Newark, N.J.
78452	Thompson-Bremer & Co.	Chicago, Ill.
78471	Tilley Mfg. Co.	San Francisco, Calif.
78488	Stackpole Carbon Co.	St. Marys, Pa.
78493	Standard Thomson Corp.	Waltham, Mass.
78553	Tinnerman Products, Inc.	Cleveland, Ohio
78790	Transformer Engineers	San Gabriel, Calif.
78947	Ucinite Co.	Newtonville, Mass.
79136	Waldes Kohinoor Inc.	Long Island City, N.Y.
79142	Veeder Root, Inc.	Hartford, Conn.
79251	Wenco Mfg. Co.	Chicago, Ill.
79727	Continental-Wirt Electronics Corp.	Philadelphia, Pa.
79963	Zierick Mfg. Corp.	New Rochelle, N.Y.
80031	Mepco Division of Sessions Clock Co.	Morristown, N.J.
80120	Schnitzer Alloy Products Co.	Elizabeth, N.J.
80131	Electronic Industries Association. Any brand Tube meeting EIA Standards-Washington, DC.	
80207	Unimax Switch, Div. Maxon Electronics Corp.	Wallingford, Conn.
80223	United Transformer Corp.	New York, N.Y.
80248	Oxford Electric Corp.	Chicago, Ill.
80294	Bourns Inc.	Riverside, Calif.
80411	Acro Div. of Robertshaw Controls Co.	Columbus, Ohio

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Table 6-4. Code List of Manufacturers (Continued)

Code No.	Manufacturer	Address
80486	All Star Products Inc.	Defiance, Ohio
80509	Avery Label Co.	Monrovia, Calif.
80583	Hammarlund Co., Inc.	Mars Hill, N.C.
80640	Stevens, Arnold, Co., Inc.	Boston, Mass.
80813	Dimco Gray Co.	Dayton, Ohio
81030	International Instruments Inc.	Orange, Conn.
81073	Grayhill Co.	LaGrange, Ill.
81095	Triad Transformer Corp.	Venice, Calif.
81312	Winchester Elec. Div. Litton Ind., Inc.	Oakville, Conn.
81349	Military Specification	. . . . .
81483	International Rectifier Corp.	El Segundo, Calif.
81541	Airpax Electronics, Inc.	Cambridge, Maryland
81860	Barry Controls, Div. Barry Wright Corp.	Watertown, Mass.
82042	Carter Precision Electric Co.	Skokie, Ill.
82047	Sperti Faraday Inc., Copper Hewitt Electric Div.	Hoboken, N.J.
82116	Electric Regulator Corp.	Norwalk, Conn.
82142	Jeffers Electronics Division of Speer Carbon Co.	Du Bois, Pa.
82170	Fairchild Camera & Inst. Corp. Space & Defense System Div.	Paramus, N.J.
82209	Maguire Industries, Inc.	Greenwich, Conn.
82219	Sylvania Electric Prod. Inc. Electronic Tube Division	Emporium, Pa.
82376	Astron Corp.	East Newark, Harrison, N,J,
82389	Switchcraft, Inc.	Chicago, Ill.
82647	Metals & Controls Inc. Spencer Products	Attleboro, Mass.
82768	Phillips-Advance Control Co.	Joliet, Ill.
82866	Research Products Corp.	Madison, Wis.
82877	Rotron Mfg. Co., Inc.	Woodstock, N.Y.
82893	Vector Electronic Co.	Glendale, Calif.
83014	Hartwell Corp.	Los Angeles, Calif.
83058	Carr Fastener Co.	Cambridge, Mass.
83086	New Hampshire Ball Bearing, Inc.	Peterborough, N.H.
83125	General Instrument Corp., Capacitor Div.	Darlington, S.C.
83148	ITT Wire and Cable Div.	Los Angeles, Calif.
83186	Victory Eng. Corp.	Springfield, N.J.
83298	Bendix Corp., Red Bank Div.	Red Bank, N.J.
83315	Hubbell Corp.	Mundelein, Ill.
83324	Rosan Inc.	Newport Beach, Calif.
83330	Smith, Herman H., Inc.	Brooklyn, N.Y.
83332	Tech Labs	Palisade's Park, N.J.
83385	Central Screw Co.	Chicago, Ill.
83501	Gavitt Wire and Cable Co. Div. of Amerace Corp.	Brookfield, Mass.
83594	Burroughs Corp. Electronic Tube Div.	Plainfield, N.J.
83740	Union Carbide Corp. Consumer Prod. Div.	New York, N.Y.
83777	Model Eng. and Mfg., Inc.	Huntington, Ind.
83821	Loyd Scruggs Co.	Festus, Mo.
83942	Aeronautical Inst. & Radio Co.	Lodi, N.J.
84171	Arco Electronics Inc.	Great Neck, N.Y.
84396	A.J. Glesener Co., Inc.	San Francisco, Calif.
84411	TRW Capacitor Div.	Ogallala, Neb.
84970	Sarkes Tarzian, Inc.	Bloomington, Ind.
85454	Boonton Molding Company	Boonton, N.J.
85471	A.B. Boyd Co.	San Francisco, Calif.
85474	R.M. Bracamonte & Co.	San Francisco, Calif.
85660	Koiled Kords, Inc.	Hamden, Conn.
85911	Seamless Rubber Co.	Chicago, Ill.
86174	Fafnir Bearing Co.	Los Angeles, Calif.
86197	Clifton Precision Products Co., Inc.	Clifton Heights, Pa.
86579	Precision Rubber Products Corp.	Dayton, Ohio
86684	Radio Corp. of America, Electronic Comp. & Devices Div.	Harrison, N.J.
86928	Seastrom Mfg. Co.	Glendale, Calif.
87034	Marco Industries	Anaheim, Calif.
87216	Philco Corporation (Lansdale Division)	Lansdale, Pa.
87473	Western Fibrous Glass Products Co.	San Francisco, Calif.
87664	Van Waters & Rogers Inc.	San Francisco, Calif.
87930	Tower Mfg. Corp.	Providence, R.I.
88140	Cutler-Hammer, Inc.	Lincoln, Ill.
88220	Gould-National Batteries, Inc.	St. Paul, Minn.
88698	General Mills, Inc.	Buffalo, N.Y.
89231	Graybar Electric Co.	Oakland, Calif.
89473	G.E. Distributing Corp.	Schenectady, N.Y.
89665	United Transformer Co.	Chicago, Ill.
90030	United Shoe Machinery Corp.	Beverly, Mass.
90179	US Rubber Co., Consumer Ind. & Plastics Prod. Div.	Passaic, N.J.
90970	Bearing Engineering Co.	San Francisco, Calif.
91146	ITT Cannon Elect, Inc., Salem Div.	Salem, Mass.
91260	Connor Spring Mfg. Co.	San Francisco, Calif.
91345	Miller Dial & Nameplate Co.	El Monte, Calif.
91418	Radio Materials Co.	Chicago, Ill.
91506	Augat Inc.	Attleboro, Mass.
91637	Dale Electronics, Inc.	Columbus, Nebr.
91662	Elco Corp.	Willow Grove, Pa.
91737	Gremar Mfg. Co., Inc.	Wakefield, Mass.
91827	K F Development Co.	Redwood City, Calif.
91886	Malco Mfg. Co., inc.	Chicago, Ill.
91929	Honeywell Inc., Micro Switch Div.	Freeport, Ill.
91961	Nahm-Bros. Spring Co.	Oakland, Calif.
92180	Tru-Connector Corp.	Peabody, Mass.
92367	Elgeet Optical Co. Inc.	Rochester, N.Y.
92607	Tensolite Insulated Wire Co., Inc.	Tarrytown, N.Y.
92702	IMC Magnetics Corp.	Wesbury Long Island, N.Y.
92966	Hudson Lamp Co.	Kearney, N.J.
93332	Sylvania Electric Prod. Inc. Semiconductor Div.	Woburn, Mass.
93369	Robbins & Myers Inc.	Palisades Park, N.J.
93410	Stemco Controls, Div. of Essex Wire Corp.	Mansfield, Ohio
93632	Waters Mfg. Co.	Culver City, Calif.
93929	G.V. Controls	Livingston, N.J.
94137	General Cable Corp.	Bayonne, N.J.
94142	Phelps Dodge	Yonkers, N.Y.
94144	Raytheon Co., Comp. Div., Ind. Comp. Operations	Quincy, Mass.
94148	Scientific Electronics Products, Inc.	Loveland, Colo.
94154	Wagner Elect. Corp., Tung-Sol Div.	Newark, N.J.
94197	Curtiss-Wright Corp. Electronics Div.	East Paterson, N.J.
94222	South Chester Corp.	Chester, Pa.
94330	Wire Cloth Products, Inc.	Bellwood, Ill.
94375	Automatic Metal Products Co.	Brooklyn, N.Y.
94682	Worcester Pressed Aluminum Corp.	Worcester, Mass.
94696	Magnecraft Electric Co.	Chicago, Ill.
95023	George A. Philbrick Researchers, Inc.	Boston, Mass.
95236	Allies Products Corp.,	Dania, Fla.
95238	Continental Connector Corp.	Woodside, N.Y.
95263	Leecraft Mfg. Co., Inc.	Long Island, N.Y.
95265	National Coil Co.	Sheridan, Wyo.
95275	Vitramon, Inc.	Bridgeport, Conn.
95348	Gordos Corp.	Bloomfield, N.J.
95354	Methode Mfg. Co.	Rolling Meadows, Ill.
95566	Arnold Engineering Co.	Marengo, Ill.
95712	Dage Electric Co., Inc.	Franklin, Ind.
95984	Siemon Mfg. Co.	Wayne, Ill.
95987	Weckesser Co.	Chicago, Ill.
96067	Microwave Assoc., West Inc.	Sunnyvale, Calif.
96095	Hi-Q Div. of Aerovox Corp.	Olean, N.Y.
96256	Thordarson-Meissner Inc.	Mt. Carmel, Ill.
96296	Solar Manufacturing Co.	Los Angeles, Calif.
96306	Microswitch, Div. of Minn.-Honeywell	Freeport, Ill.
96330	Carlton Screw Co.	Chicago, Ill.
96341	Microwave Associates, Inc.	Burlington, Mass.
96501	Excel Transformer Co.	Oakland, Calif.
96733	San Fernando Elect. Mfg. Co.	San Fernando, Calif.
96881	Thomson Ind. Inc.	Long Is., N.Y.
97464	Industrial Refaining Ring Co.	Irvington, N.J.
97539	Automatic & Precision Mfg.	Englewood, N.J.
97979	Reon Resistor Corp.	Yonkers, N.Y.
97983	Litton System Inc., Adler-Westrex Commun. Div.	New Rochelle, N.Y.
98141	R-Troncis, Inc.	Jamaica, N.Y.
98159	Rubber Teck, Inc.	Gardena, Calif.
98220	Hewlett-Packard Co., Moseley Div.	Pasadena, Calif.
98278	Microdot, Inc.	So. Pasadena, Calif.
98291	Sealectro Corp.	Mamaroneck, N.Y.
98376	Zero Mfg. Co.	Burbank, Calif.
98410	Etc Inc.	Cleveland, Ohio
98731	General Mills Inc., Electronics Div.	Minneapolis, Minn.
98734	Paeco Div. of Hewlett-Packard Co.	Palo Alto, Calif.
98821	North Hills Electronics, Inc.	Glen Cove, N.Y.
98978	International Electronic Research Corp.	Burbank, Calif.
99109	Columbia Technical Corp.	New York, N.Y.
99313	Varian Associates	Palo Alto, Calif.
99378	Atlee Corp.	Winchester, Mass.
99515	Marshall Ind., Capacitor Div.	Monrovia, Calif.
99707	Control Switch Division, Controls Co. of America	El Segundo, Calif.
99800	Delevan Electronics Corp.	East Aurora, N.Y.
99848	Wilco Corporation	Indianapolis, Ind.
99928	Branson Corp.	Whippany, N.J.
99934	Renbrandt, Inc.	Boston, Mass.
99942	Hoffman Electronics Corp. Semiconductor Div.	El Monte, Calif.
99957	Technology Instrument Corp. of Calif.	Newbury Park, Calif.

THE FOLLOWING HP VENDORS HAVE NO NUMBER ASSIGNED IN THE LATEST SUPPLEMENT TO THE FEDERAL SUPPLY CODE FOR MANUFACTURERS HANDBOOK.

0000F	Malco Tool and Die	Los Angeles, Calif.
0000Z	Willow Leather Products Corp.	Newark, N.J.
000AB	ETA	England
000BB	Precision Instrument Components Co.	Van Nuys, Calif.
000CS	Hewlett-Packard Co., Colorado Springs	Colorado Springs, Colorado
000MM	Rubber Eng. & Development	Hayward, Calif.
000NN	A "N" D Mfg. Co.	San Jose, Calif.
000QQ	Cooltron	Oakland, Calif.
000WW	California Eastern Lab.	Burlington, Calif.
000YY	S.K. Smith Co.	Los Angeles, Calif.

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SALES & SERVICE OFFICES

UNITED STATES

ALABAMA
P.O. Box 4207
2003 Byrd Spring Road S.W.
Huntsville 35802
Tel: (205) 881-4591
TWX: 810-726-2204

ARIZONA
2336 E. Magnolia St.
Phoenix 85034
Tel: (602) 252-5061
TWX: 910-951-1330

5737 East Broadway
Tucson 85716
Tel: (602) 298-2313
TWX: 910-952-1162

CALIFORNIA
1430 East Orangethorpe Ave.
Fullerton 92631
Tel: (714) 870-1000

3939 Lankershim Boulevard
North Hollywood 91604
Tel: (213) 877-1282
TWX: 910-499-2170

1101 Embarcadero Road
Palo Alto 94303
Tel: (415) 327-6500
TWX: 910-373-1280

2220 Watt Ave.
Sacramento 95825
Tel: (916) 482-1463
TWX: 910-367-2092

9606 Aero Drive
San Diego 92123
Tel: (714) 279-3200
TWX: 910-335-2000

COLORADO
7965 East Prentice
Englewood 80110
Tel: (303) 771-3455
TWX: 910-935-0705

CONNECTICUT
12 Lunar Drive
New Haven 06525
Tel: (203) 389-6551
TWX: 710-465-2029

FLORIDA
P.O. Box 24210
2806 W. Oakland Park Blvd.
Ft. Lauderdale 33307
Tel: (305) 731-2020
TWX: 510-955-4099

P.O. Box 13910
6177 Lake Ellenor Dr.
Orlando, 32809
Tel: (305) 859-2900
TWX: 810-850-0113

GEORGIA
P.O. Box 28234
450 Interstate North
Atlanta 30328
Tel: (404) 436-6181
TWX: 810-766-4890

ILLINOIS
5500 Howard Street
Skokie 60076
Tel: (312) 677-0400
TWX: 910-223-3613

INDIANA
3839 Meadows Drive
Indianapolis 46205
Tel: (317) 546-4891
TWX: 810-341-3263

LOUISIANA
P.O. Box 856
1942 Williams Boulevard
Kenner 70062
Tel: (504) 721-6201
TWX: 810-955-5524

MARYLAND
6707 Whitestone Road
Baltimore 21207
Tel: (301) 944-5400
TWX: 710-862-9157

P.O. Box 1648
2 Choke Cherry Road
Rockville 20850
Tel: (301) 948-6370
TWX: 710-828-9684

MASSACHUSETTS
32 Hartwell Ave.
Lexington 02173
Tel: (617) 861-8960
TWX: 710-326-6904

MICHIGAN
21840 West Nine Mile Road
Southfield 48075
Tel: (313) 353-9100
TWX: 810-224-4882

MINNESOTA
2459 University Avenue
St. Paul 55114
Tel: (612) 645-9461
TWX: 910-563-3734

MISSOURI
11131 Colorado Ave.
Kansas City 64137
Tel: (816) 763-8000
TWX: 910-771-2087

148 Weldon Parkway
Maryland Heights 63043
Tel: (314) 567-1455
TWX: 910-764-0830

NEW JERSEY
W. 120 Century Road
Paramus 07652
Tel: (201) 265-5000
TWX: 710-990-4951

1060 N. Kings Highway
Cherry Hill 08034
Tel: (609) 667-4000
TWX: 710-892-4945

NEW MEXICO
P.O. Box 8366
Station C
6501 Lomas Boulevard N.E.
Albuquerque 87108
Tel: (505) 265-3713
TWX: 910-989-1665

156 Wyatt Drive
Las Cruces 88001
Tel: (505) 526-2485
TWX: 910-983-0550

NEW YORK
1702 Central Avenue
Albany 12205
Tel: (518) 869-8462
TWX: 710-441-8270

1219 Campville Road
Endicott 13760
Tel: (607) 754-0050
TWX: 510-252-0890

82 Washington Street
Poughkeepsie 12601
Tel: (914) 454-7330
TWX: 510-248-0012

39 Saginaw Drive
Rochester 14623
Tel: (716) 473-9500
TWX: 510-253-5981

5858 East Molloy Road
Syracuse 13211
Tel: (315) 454-2486
TWX: 710-541-0482

1 Crossways Park West
Woodbury 11797
Tel: (516) 921-0300
TWX: 510-223-0811

NORTH CAROLINA
P.O. Box 5188
1923 North Main Street
High Point 27262
Tel: (919) 885-8101
TWX: 510-926-1516

OHIO
25575 Center Ridge Road
Cleveland 44145
Tel: (216) 835-0300
TWX: 810-427-9129

3460 South Dixie Drive
Dayton 45439
Tel: (513) 298-0351
TWX: 810-459-1925

1120 Morse Road
Columbus 43229
Tel: (614) 846-1300

OKLAHOMA
2919 United Founders Boulevard
Oklahoma City 73112
Tel: (405) 848-2801
TWX: 910-830-6862

OREGON
Westhills Mall, Suite 158
4475 S.W. Scholls Ferry Road
Portland 97225
Tel: (503) 292-9171
TWX: 910-464-6103

PENNSYLVANIA
2500 Moss Side Boulevard
Monroeville 15146
Tel: (412) 271-0724
TWX: 710-797-3650

1021 8th Avenue
King of Prussia Industrial Park
King of Prussia 19406
Tel: (215) 265-7000
TWX: 510-660-2670

RHODE ISLAND
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East Providence 02914
Tel: (401) 434-5535
TWX: 710-381-7573

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Memphis
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Richardson 75080
Tel: (214) 231-6101
TWX: 910-867-4723

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6300 Westpark Drive
Suite 100
Houston 77027
Tel: (713) 781-6000
TWX: 910-881-2645

231 Billy Mitchell Road
San Antonio 78226
Tel: (512) 434-4171
TWX: 910-871-1170

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Salt Lake City 84115
Tel: (801) 487-0715
TWX: 910-925-5681

VERMONT
P.O. Box 2287
Kennedy Drive
South Burlington 05401
Tel: (802) 658-4455
TWX: 510-299-0025

VIRGINIA
P.O. Box 6514
2111 Spencer Road
Richmond 23230
Tel: (703) 285-3431
TWX: 710-956-0157

WASHINGTON
433-108th N.E.
Bellevue 98004
Tel: (206) 454-3971
TWX: 910-443-2303

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Charleston
Tel: (304) 768-1232

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Hewlett-Packard (Canada) Ltd.
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Edmonton
Tel: (403) 452-3670
TWX: 610-831-2431

BRITISH COLUMBIA
Hewlett-Packard (Canada) Ltd.
4519 Canada Way
North Burnaby 2
Tel: (604) 433-8213
TWX: 610-922-5059

MANITOBA
Hewlett-Packard (Canada) Ltd.
513 Century St.
Winnipeg
Tel: (204) 786-7581
TWX: 610-671-3531

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Hewlett-Packard (Canada) Ltd.
2745 Dutch Village Rd.
Suite 206
Halifax
Tel: (902) 455-0511
TWX: 610-271-4482

ONTARIO
Hewlett-Packard (Canada) Ltd.
1785 Woodward Dr.
Ottawa 3
Tel: (613) 255-6180, 255-6530
TWX: 610-562-1952

Hewlett-Packard (Canada) Ltd.
50 Galaxy Blvd.
Rexdale
Tel: (416) 677-9611
TWX: 610-492-4246

QUEBEC
Hewlett-Packard (Canada) Ltd.
275 Hymus Boulevard
Pointe Claire
Tel: (514) 697-4232
TWX: 610-422-3022
Telex: 01-20607

FOR CANADIAN AREAS NOT LISTED:
Contact Hewlett-Packard (Canada) Ltd. in Pointe Claire, at the complete address listed above.

CENTRAL AND SOUTH AMERICA

ARGENTINA
Hewlett-Packard Argentina S.A.C.e.I
Lavalle 1171 - 3°
Buenos Aires
Tel: 35-0436, 35-0627, 35-0431
Telex: 012-1009
Cable: HEWPACK ARG

BRAZIL
Hewlett-Packard Do Brasil I.e.C Ltda.
Rua Frei Caneca 1119
Sao Paulo - 3, SP
Tel: 288-7111, 287-5858
Cable: HEWPACK Sao Paulo

Hewlett-Packard Do Brasil
Praca Dom Feliciano 78
Salas 806/808
Porto Alegre
Rio Grande do Sul (RS)-Brasil
Tel: 25-8470
Cable: HEWPACK Porto Alegre

Hewlett-Packard Do Brasil I.e.C. Ltda.
Rua da Matriz 29
Botafogo ZC-02
Rio de Janeiro, GB
Tel: 246-4417, 246-2919
Cable: HEWPACK Rio de Janeiro

CHILE
Héctor Calcagni y Cia, Ltda.
Bustos, 1932-3er Piso
Casilla 13942
Santiago
Tel: 423 96
Cable: CALCAGNI Santiago

COLOMBIA
Instrumentacion
Henrik A. Langebaek & Kier S.A.
Carrera 7 No. 48-59
Apartado Aereo 6287
Bogota, 1 D.E.
Tel: 45-78-06, 45-55-46
Cable: AARIS Bogota
Telex: 44400INSTCO

COSTA RICA
Lic. Alfredo Gallegos Gurdián
Apartado 10159
San José
Tel: 21-86-13
Cable: GALGUR San José

ECUADOR
Laboratorios de Radio-Ingenieria
Calle Guayaquil 1246
Post Office Box 3199
Quito
Tel: 212-496; 219-185
Cable: HORVATH Quito

EL SALVADOR
Electronic Associates
Apartado Postal 1682
Centro Comercial Gigante
San Salvador, El Salvador C.A.
Paseo Escalon 4649-4° Piso
Tel: 23-44-60, 23-32-37
Cable: ELECAS

GUATEMALA
IPESA
5a via 2-01, Zona 4
Guatemala City

MEXICO
Hewlett-Packard Mexicana, S.A. de C.V.
622 Adolfo Prieto
Col. del Valle
Mexico 12, D.F.
Tel: 543-4232; 523-1874
Telex: 017-74-507

NICARAGUA
Roberto Terán G.
Apartado Postal 689
Edificio Terán
Managua
Tel: 3451, 3452
Cable: ROTERAN Managua

PANAMA
Electrónico Balboa, S.A.
P.O. Box 4929
Ave. Manuel Espinosa No. 13-50
Bldg. Alina
Panama City
Tel: 230833
Telex: 3481003, Curundu, Canal Zone
Cable: ELECTRON Panama City

PARAGUAY
Z.T. Melamed S.R.L.
Division: Aparatos y Equipos Medicos
Salon de Exposicion y Escritorio:
Chile 482
Edificio Victoria—Planta Baja
Asuncion, Paraguay
Tel: 4-5069, 4-6272
Cable: RAMEL

PERU
Compañia Electro Medica S.A.
Ave. Enrique Canaual 312
San Isidro
Casilla 1030
Lima
Tel: 22-3900
Cable: ELMED Lima

PUERTO RICO
San Juan Electronics, Inc.
P.O. Box 5167
Ponce de Leon 154
Pda. 3-PTA de Tierra
San Juan 00906
Tel: (809) 725-3342, 722-3342
Cable: SATRONICS San Juan
Telex: SATRON 3450 332

URUGUAY
Pablo Ferrando S.A.
Comercial e Industrial
Avenida Italia 2877
Casilla de Correo 370
Montevideo
Tel: 40-3102
Cable: RADIUM Montevideo

VENEZUELA
Hewlett-Packard De Venezuela C.A.
Apartado 50933
Caracas
Tel: 71.88.05, 71.88.69, 71.99.30
Cable: HEWPACK Caracas
Telex: 21146 HEWPACK

FOR AREAS NOT LISTED,

CONTACT:
Hewlett-Packard INTERCONTINENTAL
3200 Hillview Ave.
Palo Alto, California 94304
Tel: (415) 493-1501
TWX: 910-373-1267
Cable: HEWPACK Palo Alto
Telex: 034-8300, 034-8493

EUROPE

AUSTRIA
Hewlett-Packard Ges.m.b.H
Innstrasse 23/2
Postfach 45
A-1204 **Vienna**
Tel: (0222) 33 66 06 to 09
Cable: HEWPAK Vienna
Telex: 75923 hewpak a

BELGIUM
Hewlett-Packard Benelux
S.A./N.V.
Avenue du Col-Vert, 1
B-1170 **Brussels**
Tel: (02) 72 22 40
Cable: PALOBEN Brussels
Telex: 23 494

DENMARK
Hewlett-Packard A/S
Datavej 38
DK-3460 **Birkerod**
Tel: (01) 81 66 40
Cable: HEWPACK AS
Telex: 16640 hp as

Hewlett-Packard A/S
Torvet 9
DK-8600 **Silkeborg**
Tel: (06)-82-71-66
Telex: 16640 hp as
Cable: HEWPACKAS

FINLAND
Hewlett-Packard Oy
Bulevardi 26
P.O. Box 12185
SF-00120 **Helsinki** 12
Tel: 13-730
Cable: HEWPACKOY-Helsinki
Telex: 17-1563 hel

FRANCE
Hewlett-Packard France
Quartier de Courtaboeuf
Boite Postale No. 6
F-91 **Orsay**
Tel: (1) 907 78 25
Cable: HEWPACK Orsay
Telex: 60048

Hewlett-Packard France
4 Quai des Etroits
F-69 **Lyon** 5ème
Tel: (78) 42 63 45
Cable: HEWPACK Lyon
Telex: 31617

Hewlett-Packard France
29 rue de la Gare
F-31 **Blagnac**
Tel: (61) 85 82 29
Telex: 51957

GERMAN FEDERAL REPUBLIC
Hewlett-Packard Vertriebs-GmbH
Berliner Strasse 117
Postfach 560 140
D-6 Nieder-Eschbach/Ffm 56
Tel: (0611) 50-04-1
Cable: HEWPACKSA Frankfurt
Telex: 41 32 49 FRA

Hewlett-Packard Vertriebs-GmbH
Herrenbergerstrasse 110
D-7030 **Böblingen**, Württemberg
Tel: (07031) 66 72 86-87
Cable: HEPAK Böblingen
Telex: 72 65 739 bbn

Hewlett-Packard Vertriebs-GmbH
Vogelsanger Weg 38
D-4 **Düsseldorf**
Tel: (0211) 63 80 31/35
Telex: 85/86 533 hpdd d

Hewlett-Packard Vertriebs-GmbH
Wendenstr. 23
D-2 **Hamburg** 1
Tel: (0411) 24 05 51/52
Cable: HEWPACKSA Hamburg
Telex: 21 53 32 hphh d

Hewlett-Packard Vertriebs-GmbH
Unterhachinger Strasse 28
ISAR Center
D-8012 **Ottobrunn**
Tel: (0811) 60 13 061-7
Telex: 52 49 85
Cable: HEWPACKSA München

(West Berlin)
Hewlett-Packard Vertriebs-GmbH
Wilmersdorfer Strasse 113/114
D-1000 **Berlin W.** 12
Tel: (0311) 3137046
Telex: 18 34 05 hpbln d

GREECE
Kostas Karayannis
18, Ermou Street
Athens 126
Tel: 3230-303
Cable: RAKAR Athens
Telex: 21 59 62 rkar gr

IRELAND
Hewlett-Packard Ltd.
224 Bath Road
Slough, SL1 4 DS, Bucks
Tel: Slough 753-33341
Cable: HEWPIE Slough
Telex: 84413

ITALY
Hewlett-Packard Italiana S.p.A.
Via Amerigo Vespucci 2
1-20124 **Milan**
Tel: (2) 6251 (10 lines)
Cable: HEWPACKIT Milan
Telex: 32046

Hewlett-Packard Italiana S.p.A.
Piazza Marconi
1-00144 **Rome** - Eur
Tel: (6) 5912544/5, 5915947
Cable: HEWPACKIT Rome
Telex: 61514

Hewlett-Packard Italiana S.p.A.
Vicolo Pastori, 3
I-35100 **Padova**
Tel: (49) 66 40 62
Telex: 32046 via Milan

Hewlett-Packard Italiana S.p.A.
Via Colli, 24
I-10129 **Turin**
Tel: (11) 53 82 64
Telex: 32046 via Milan

LUXEMBURG
Hewlett-Packard Benelux
S.A./N.V.
Avenue du Col-Vert, 1
B-1170 **Brussels**
Tel: (03/02) 72 22 40
Cable: PALOBEN Brussels
Telex: 23 494

NETHERLANDS
Hewlett-Packard Benelux, N.V.
Weerdestein 117
P.O. Box 7825
Amsterdam, Z 11
Tel: 020-42 77 77
Cable: PALOBEN Amsterdam
Telex: 13 216 hepa ni

NORWAY
Hewlett-Packard Norge A/S
Box 149
Nesveien 13
N-1344 **Haslum**
Tel: (02)-53 83 60
Telex: 16621

PORTUGAL
Telectra-Empresa Tecnica de Equipamentos
Electricos S.a.r.l.
Rua Rodrigo da Fonseca 103
P.O. Box 2531
P-**Lisbon** 1
Tel: (19) 68 60 72
Cable: TELECTRA Lisbon
Telex: 1598

SPAIN
Hewlett-Packard Española, S.A.
Jerez No 8
Madrid 16
Tel: 458 26 00
Telex: 23515 hpe

Hewlett-Packard Española, S.A.
Milanesado 21-23
E-**Barcelona** 17
Tel: (3) 203 62 00

SWEDEN
Hewlett-Packard Sverige AB
Enighetsvägen 1-3
Fack
S-161 20 **Bromma** 20
Tel: (08) 98 12 50
Cable: MEASUREMENTS Stockholm
Telex: 10721

Hewlett-Packard Sverige AB
Hagakersgatan 9C
S-431 41 **Mölndal**
Tel: (031) 27 68 00/01
Telex: 21 312 hpmindl s

SWITZERLAND
Hewlett Packard (Schweiz) AG
Zürcherstrasse 20
P.O. Box 64
CH-8952 **Schlieren** Zurich
Tel: (01) 98 18 21/24
Cable: HPAG CH
Telex: 53933

Hewlett-Packard (Schweiz) AG
Rue du Bois-du-Lan 7
P.O. Box 85
1217 Meyrin 2 **Geneva**
Tel: (022) 41 54 00
Cable: HEWPACKSA Geneva
Telex: 27333 hpsa ch

TURKEY
Telekom Engineering Bureau
P.O. Box 376
Karaköy
Istanbul
Tel: 49 40 40
Cable: TELEMATION Istanbul

UNITED KINGDOM
Hewlett-Packard Ltd.
224 Bath Road
Slough, SL1 4 DS, Bucks
Tel: Slough (0753) 33341
Cable: HEWPIE Slough
Telex: 84413

Hewlett-Packard Ltd.
"The Graftons"
Stamford New Road
Altrincham, Cheshire
Tel: (061) 928-8626
Telex: 668068

SOCIALIST COUNTRIES PLEASE CONTACT:
Hewlett-Packard Ges.m.b.H
Innstrasse 23/2
Postfach 45
A-1204 **Vienna**, Austria
Tel: (0222) 33 66 06-09
Cable: HEWPACK Vienna
Telex: 75923 hewpak a

ALL OTHER EUROPEAN COUNTRIES CONTACT:
Hewlett-Packard S.A.
Rue du Bois-du-Lan 7
P.O. Box 85
CH-1217 Meyrin 2 **Geneva**
Switzerland
Tel: (022) 41 54 00
Cable: HEWPACKSA Geneva
Telex: 2.24.86

AFRICA, ASIA, AUSTRALIA

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Telectra Empresa Técnia de Equipamentos Eléctricos SAR
Rua de Barbosa Rodrigues 42-1°
Box 6487
Luanda
Cable: TELECTRA Luanda

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Telex: 31 024

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Crows Nest 2065
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Telex: 21561

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South Australia
Tel: 65-2366
Cable: HEWPARD Adelaide

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2nd Floor, Suite 13
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196 Adelaide Terrace
Perth, W.A. 6000
Tel: 21-3330
Cable: HEWPARD Perth

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P.O. Box 191
Dickson A.C.T. 2602
Tel: 49-8194
Cable: HEWPARD Canberra ACT

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6 Harvard Street
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Kenmore 4069 Queensland
Tel: 70-4050

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Yehala Building
Staples Street
Colombo 2
Tel: 5496
Cable: HOTPOINT Colombo

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Kypronics
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P.O. Box 1152
Nicosia
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Cable: HE-I-NAMI

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58/59 Cunningham St.
Addis Ababa
Tel: 12285
Cable: ASACO Addisababa

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1511, Prince's Building 15th Floor
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Hong Kong
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Cable: SCHMIDTCO Hong Kong

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Kasturi Buildings
Jamshedji Tata Rd.
Bombay 20BR, India
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Telex: 3751
Cable: BLUEFROST

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Prabhadevi
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Telex: 3751
Cable: BLUESTAR

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Cable: BLUESTAR

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Calcutta 1, India
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Telex: 655
Cable: BLUESTAR

Blue Star Ltd.
Blue Star House,
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Lajpat Nagar
New Delhi 24, India
Tel: 62 32 76
Telex: 463
Cable: BLUESTAR

Blue Star, Ltd.
Blue Star House
11/11A Magarath Road
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Tel: 51473
Telex: 430
Cable: BLUESTAR

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1-1-117/1
Sarojini Devi Road
Secunderabad 3
Tel: 7 63 91, 7 73 93
Cable: BLUEFROST

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23/24 Second Line Beach
Madras 1, India
Tel: 2 39 55
Telex: 379
Cable: BLUESTAR

Blue Star, Ltd.
1B Kaiser Bungalow
Dindli Road
Jamshedpur, India
Tel: 38 04
Cable: BLUESTAR

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Bah Bolon Trading Coy. N.V.
Djalah Merdeka 29
Bandung
Tel: 4915; 51560
Cable: ILMU
Telex: 08-809

IRAN
Multicorp International Ltd.
Avenue Soraya 130
P.O. Box 1212
Teheran
Tel: 83 10 35-39
Cable: MULTICORP Tehran
Telex: 2876 service tn

ISRAEL
Electronics & Engineering Div. of Motorola Israel Ltd.
17 Aminadav Street
Tel-Aviv
Tel: 36941 (3 lines)
Cable: BASTEL Tel-Aviv
Telex: MOTIL IL

JAPAN
Yokogawa-Hewlett-Packard Ltd.
Ohashi Building
1-59-1 Yoyogi
Shibuya-ku, Tokyo
Tel: 03-370-2281/92
Telex: 232-2024YHP
Cable: YHPMARKET TOK 23-724

Yokogawa-Hewlett-Packard Ltd.
Nisei Ibaragi Bldg.
2-2-8 Kasuga
Ibaragi-Shi
Osaka
Tel: (0726) 23-1641
Telex: 5332-385 YHP OSAKA

Yokogawa-Hewlett-Packard Ltd.
Ito Building
No. 59, Kotori-cho
Nakamura-ku, Nagoya City
Tel: (052) 551-0215

Yokogawa-Hewlett-Packard Ltd.
Nitto Bldg.
2-4-2 Shinohara-Kita
Kohoku-ku
Yokohama 222
Tel: 045-432-1504
Telex: 382-3204 YHP YOK

JORDAN
Constantin E. Macridis
Clemenceau Street
P.O. Box 7213
Beirut, Lebanon
Tel: 220846
Cable: ELECTRONUCLEAR Beirut

KENYA
Kenya Kinetics
P.O. Box 18311
Nairobi, Kenya
Tel: 57726
Cable: PROTON

KOREA
Amtraco Corporation
Industrial Products Div.
Seoul P.O. Box 1103
8th floor, DaeKyung Bldg.
107 Sejong Ro
Chongro-Ku, Seoul
Tel: 73-8924-7
Cable: AMTRACO Seoul

LEBANON
Constantin E. Macridis
Clemenceau Street
P.O. Box 7213
Beirut
Tel: 220846
Cable: ELECTRONUCLEAR Beirut

MALAYSIA
MECOMB Malaysia Ltd.
2 Lorong 13/6A
Section 13
Petaling Jaya, **Selangor**
Cable: MECOMB Kuala Lumpur

MOZAMBIQUE
A. N. Goncalves, LDA.
4.1 Apt. 14 Av. D. Luis
P.O. Box 107
Lourenco Marques
Cable: NEGON

NEW ZEALAND
Hewlett-Packard (N.Z.) Ltd.
94-96 Dixson St.
P.O. Box 9443
Wellington, N.Z.
Tel: 56-559
Cable: HEWPACK Wellington

Hewlett Packard (N.Z.) Ltd.
Box 51092
Pukuranga
Tel: 56-9837
Cable: HEWPACK, Auckland

PAKISTAN
Mushko & Company, Ltd.
Oosman Chambers
Abdullah Haroon Road
Karachi 3
Tel: 511027, 512927
Cable: COOPERATOR Karachi

Mushko & Company, Ltd.
38B, Satellite Town
Rawalpindi
Tel: 41924
Cable: FEMUS Rawalpindi

PHILIPPINES
Electromex Inc.
5th Floor, Architects Center Bldg.
Ayala Ave., Makati, Rizal
C.C.P.O. Box 1028
Makati, Rizal
Tel: 86-18-87, 87-76-77
Cable: ELEMEX Manila

SINGAPORE
Mechanical and Combustion Engineering Company Ltd.
9, Jalan Kilang
Red Hill Industrial Estate
Singapore, 3
Tel: 642361-3; 632611
Cable: MECOMB Singapore

Hewlett-Packard Far East Area Office
P.O. Box 87
Alexandra Post Office
Singapore 3
Tel: 633022
Cable: HEWPACK SINGAPORE

SOUTH AFRICA
Hewlett Packard South Africa (Pty.), Ltd.
P.O. Box 31716
Braamfontein Transvaal
Milnerton
30 De Beer Street
Johannesburg
Tel: 725-2080, 725-2030
Telex: 0226 JH
Cable: HEWPACK Johannesburg

Hewlett Packard South Africa (Pty.), Ltd.
Breecastle House
Bree Street
Cape Town
Tel: 3-6019, 3-6545
Cable: HEWPACK Cape Town
Telex: 5-0006

Hewlett Packard South Africa (Pty.), Ltd.
641 Ridge Road, Durban
P.O. Box 99
Overport, Natal
Tel: 88-6102
Telex: 567954
Cable: HEWPACK

TAIWAN
Hewlett Packard Taiwan
39 Chung Shiao West Road
Sec. 1
Overseas Insurance Corp. Bldg. 7th Floor
Taipei
Tel: 389160,1,2, 375121, Ext. 240-249
Telex: TP824 HEWPACK
Cable: HEWPACK Taipei

THAILAND
UNIMESA Co., Ltd.
Chongkoinee Building
56 Suriwongse Road
Bangkok
Tel: 37956, 31300, 31307, 37540
Cable: UNIMESA Bangkok

UGANDA
Uganda Tele-Electric Co., Ltd.
P.O. Box 4449
Kampala
Tel: 57279
Cable: COMCO Kampala

VIETNAM
Peninsular Trading Inc.
P.O. Box H-3
216 Hien-Vuong
Saigon
Tel: 20-805, 93398
Cable: PENTRA, SAIGON 242

ZAMBIA
R. J. Tilbury (Zambia) Ltd.
P.O. Box 2792
Lusaka
Zambia, Central Africa
Tel: 73793
Cable: ARJAYTEE, Lusaka

MEDITERRANEAN AND MIDDLE EAST COUNTRIES NOT SHOWN PLEASE CONTACT:
Hewlett-Packard
Co-ordination Office for Mediterranean and Middle East Operations
Via Marocco, 7
I-00144 Rome-Eur, Italy
Tel: (6) 59 40 29
Cable: HEWPACKIT Rome
Telex: 61514

OTHER AREAS NOT LISTED, CONTACT:
Hewlett-Packard
INTERCONTINENTAL
3200 Hillview Ave.
Palo Alto, California 94304
Tel: (415) 326-7000
(Feb. 71 493-1501)
TWX: 910-373-1267
Cable: HEWPACK Palo Alto
Telex: 034-8300, 034-8493